ELECTRICAL EQUIPMENT OF A GREAT GROUP OF OFFICE BUILDINGS

By
HENRY C. MEYER JR.
AND
BASSETT JONES JR.

ISSUED BY L.K. COMSTOCK & CO.

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Electric Generating, Distributing, Motor and Illuminating Installations of the Buildings of the Prudential Insurance Company at Newark, N. J.

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INTRODUCTION.

APART from its intrinsic value as a description of the solution of a difficult problem in electrical design and construction, we believe that the article from the columns of the *Electrical World* herein reprinted will serve to draw attention to the importance of cooperative service on the part of the contractor. The electrical equipment of buildings has risen by leaps and bounds from small beginnings, until to-day it has become a large and important factor in every building operation. The mass of material that must be installed to meet the demands of the modern public for electrical conveniences has given rise to a structural problem of no small complexity, and one that must receive careful consideration at the hands of the Architect.

It is essential that proper provision be made in advance to care for the extensive riser system, and means for distribution and connection that every such installation requires. And to do this it should be possible to carry out careful detail studies of the construction in advance of actual work, in order that unfortunate confusion and conflict may not arise. The time for such complete studies, however, is not always available and it is commonly necessary for the Architect and his engineer to make general provision for the electrical requirements of the building, and to map out and specify the general scheme of the installation, leaving details of construction to such times as may be convenient and proper after the work has been commenced.

Even if it were possible to prepare for every apparent detail in advance, it is generally true that in the very limited space usually available for mechanical and electrical equipment, numerous adjustments between the work of the various trades concerned must be made, and no amount of care in preliminary design that does not extend over an impractical period of time can obviate such difficulties.

The detail designs must, in general, be made from field studies after the construction of the building is sufficiently advanced.

It has, therefore, become the custom for the engineer to prepare

general drawings of the system of distribution desired and also certain drawings of structural details, all of which shall be embodied in scale working drawings, to be prepared by the electrical contractor from field data and submitted for approval.

This requires of the Contractor a definite service, which he must be prepared to fulfil, and to do so in a satisfactory manner, he must so organize his force and business methods that this important part of his function can be carried out in an economical and satisfactory manner.

We believe that one of the principal causes of dissatisfaction in the electrical business today is lack of appreciation on the part of most contractors of the fact that the large, complicated, modern electrical installation cannot be handled successfully from the old "jobbing" viewpoint. Such work can only be properly executed by an organization built upon sound business and engineering principles.

The purchasing of material alone becomes a salient factor in such problems, the preparation of drawings, the scheduling of the work, the practical engineering, the handling of labor, the delivery of apparatus, checking, estimating, changes or extensions—all of these are part of the work requiring a different viewpoint on the part of those responsible therefor, and all should be under immediate and capable executive supervision.

We could go on to some extent in attempting to describe what we believe to be the only rational and economical way of executing such contracts, but we think enough has been said to indicate the fact that it is only through such systematization and organization on modern business lines that the contractor can hope to meet acute competition and, at the same time, give satisfactory service.

Not many equipments like that in the Prudential Buildings are likely to be required, and it is precisely for this reason that this installation serves as an excellent example of the application of the principles set forth above. We feel no little pride in the fact that a work of such magnitude and difficulty has been successfully executed with entire freedom from friction and complaint.

L. K. COMSTOCK & CO.

ELECTRICAL FEATURES OF A REMODELED OFFICE BUILDING PLANT.

(Reprinted from Editorial, *Electrical World*, issue of January 13, 1912.)

AN electrical lighting and motor load in a single group of office buildings which has reached such enormous proportions as to render service at 120 volts economically disadvantageous and to indicate the necessity for a three-wire, 240-volt system is one well worthy of record in our columns. Moreover, space limitations which preclude the installation of a direct-control switchboard and dictate the use of remote control for such an equipment are so unusual as to be classed as unique. The change from a 120-volt, two-wire, direct-control system to a three-wire, 240-volt remote-control system, while maintaining uninterrupted service at all important points, is an accomplishment of no small interest. The arrangement of underfloor office-lighting circuits in such a manner that any desired changes can be made in the location of the office furniture at the minimum of expense and without damage to the appearance of the floor is a feature which will be appreciated at once by all wiring contractors and office-building owners. The above represent some of the many interesting features of the electrical equipment of the office buildings of the Prudential Insurance Company, which is described at length in an article by Messrs. Henry C. Meyer, Jr., and Bassett Jones, Jr., the first instalment of which appears in this issue.

It is not usually considered difficult to design a complete new electrical generating, transmitting and distributing equipment for localized service. However, the problem assumes an entirely different aspect when it is coupled with the necessity of maintaining an existing service uninterrupted, of utilizing existing equipment to the fullest extent economically possible, and of installing the new equipment in such cramped space as is available for the purpose after all other demands for space have been met. A simple solution of the problem would be to enlarge the present equipment to carry the increased load. In the case of the Prudential installation a careful study of the conditions showed that the cost of extending the plant according to the

existing arrangement would be prohibitive, a better and highly satisfactory solution of the numerous difficulties being found by resorting to the remote-control, three-wire arrangement. In carrying out the plans adopted, the difficulties actually encountered were more largely mechanical than electrical, on account of the presence of other equipment, especially a multiplicity of ducts and pipes in the space where the electrical conduits could best be located.

A complete study was made of the existing distributing circuits, ducts and pipes, and working drawings in detail were prepared preliminary to the actual work of reconstruction, but subsequent to the letting of the contracts for the work. In this way the major difficulties which would otherwise have arisen on numerous occasions were avoided. Many of the minor difficulties encountered were of such a character that they could not be specifically predicted before the work was begun. It was necessary, therefore, to plan for some of the reconstruction while the work was being done. To the hearty co-operation of the consulting engineers, contractors, architects and manufacturers for the ultimate benefit of the owners can be attributed the results obtained in the Prudential plant, to which all parties interested now point with pardonable pride.

ELECTRIC GENERATING, DISTRIBUTING, MOTOR AND ILLUMINATING INSTALLATIONS OF THE BUILDINGS OF THE PRUDENTIAL INSURANCE COMPANY AT NEWARK, N. J.*

By Henry C. Meyer, Jr., and Bassett Jones, Jr.

IN the half-basement of the State Bank Building, at the corner of Broad and Mechanic Streets, in Newark, N. J., was located the first home of the Prudential Friendly Society, which afterward became the Prudential Insurance Company of America. It occupied this building from 1875 to 1878. In 1878 the society moved to the first floor of the Centennial Building, at 215 Market Street, now the *Evening News* Building, where it remained until 1883. In 1883 the company moved to 878–880 Broad Street.

In 1890, as the company had outgrown its quarters, it was decided to erect a permanent home at the southwest corner of Broad and Bank Streets. Work was begun in this year, and the company moved during 1892. This building, then and now known as the Prudential Building, is a fine example of romanesque gothic designed by Messrs. George B. Post & Sons, which firm has also designed all the buildings constituting the present group.

By 1899 the company's business had increased so enormously that extra quarters had been rented in various loft and office buildings in the vicinity, and it became evident that if the work of this organization was to be carried on with proper economies further building operations were imperative. In that year, therefore, the foundations were laid for an imposing group of structures known as the Main Building and the West Building, on the south side of Bank Street, adjoining each other and the Prudential Building; also for the North Building, on the north side of Bank Street, and the Northwest Building, on the northwest corner of Bank and Halsey Streets.

These buildings were completed in 1900, and it then seemed that sufficient space had been provided to take care of any possible expansion for some time to come. However, the company's business continued

* Reprinted in part from the *Electrical World*.

to increase by leaps and bounds in a manner that it was quite impossible to anticipate, and in 1909 extra quarters had again been rented in nearby buildings. Work was then begun on the additions to the North Building, and this structure, with its additions recently completed, occupies nearly the entire block bounded by Broad, Bank, Halsey, and Academy Streets.

At the same time that the additions to the North Building were designed other building operations were in contemplation which, it is presumed, will be carried out as fast as the demand for them justifies their construction.

A view of the entire group of buildings as it exists to-day is shown on this page, and the general arrangement of buildings is indicated in Fig. 3.

MAGNITUDE OF THE BUILDINGS.

Some idea of the magnitude of the structures may be gained from the statistics printed below.

The total cubage of the entire group is 15,706,792 cu. ft. The buildings are approximately 180 ft. high to the ridge-pole. The North Building tower reaches to a height of 268 ft.

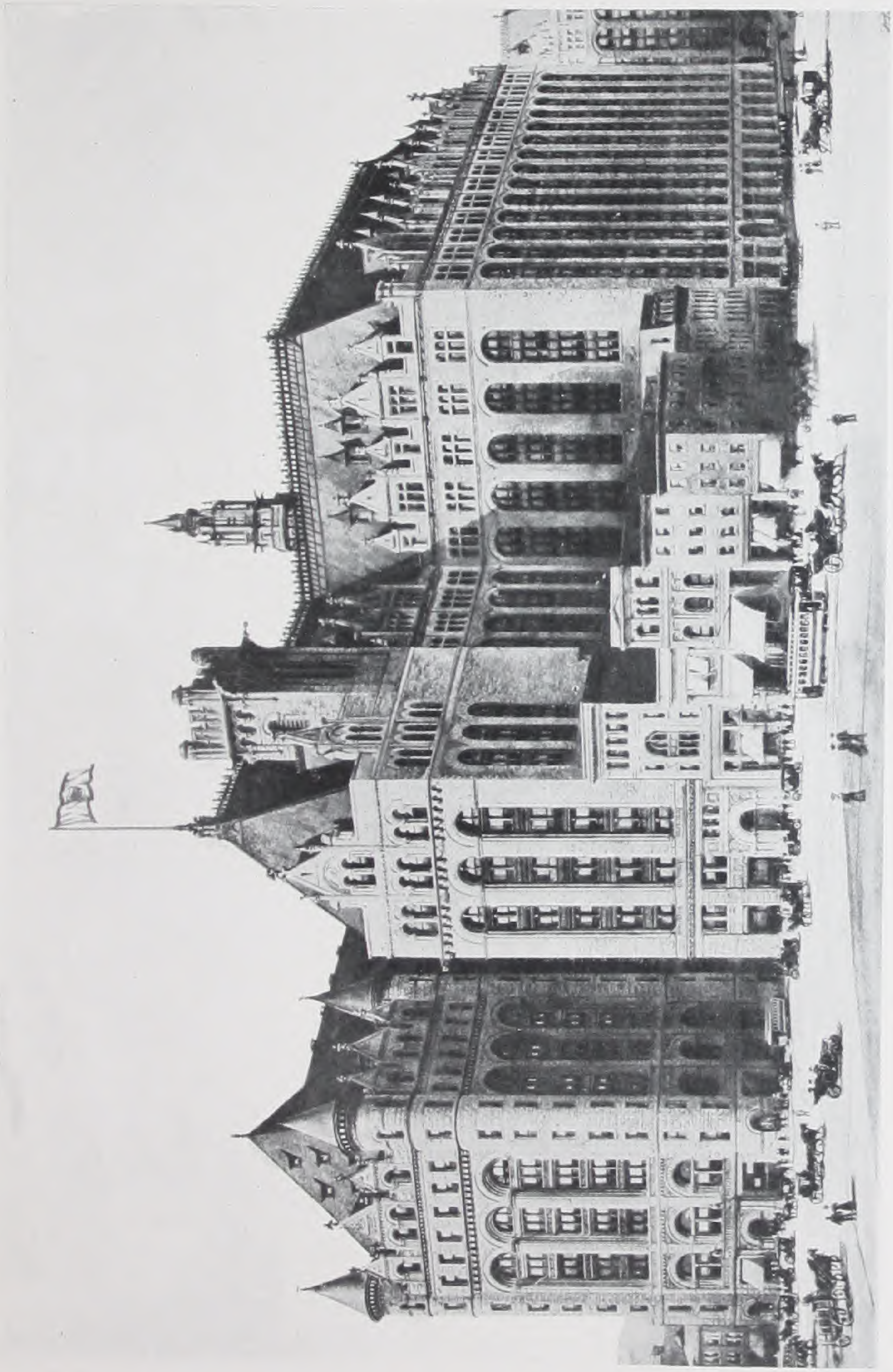
THE WORK OF TWENTY YEARS AGO.

It can well be imagined how varied would be the character of an electrical installation in buildings the construction of which was begun in 1890 and has continued from time to time through twenty years. When the Prudential Building was erected a small electric generating plant consisting of a 45-kw, 110-volt generator belted to a Corliss engine was installed. Wires were run in brass-protected paper tubes, of which some have been in use up to the recent overhauling of the wiring in all the old buildings. In fact, this building was a most interesting museum of electric-wiring apparatus since many repairs and extensive alterations had been made from time to time in which materials and devices that were the best in use at the time of their installation had been used.

The electrical work done during the building operations of 1899–1902,

Building.	*Floor Area, Square Feet*
Prudential	111,865
Main	87,735
West	46,901
Northwest	67,631
North	82,075
Academy Street	211,402
Bank and Broad Street	152,266
Total	759,875

which was installed by Messrs. Pattison Brothers as consulting engineers, was the most modern and best of its day and attracted much favorable



Prudential Group.

comment. Practically the entire first floor and basement of the North Building were given over to a heating, lighting, elevator, and auxiliary plant of large proportions (Fig. 3). Particular attention was given to the arrangement and finish of this equipment, as the entire engine-room was visible from the street. The generating equipment consisted of three 250-kw and one 150kw, 120-volt direct-current generator of Bullock make, directly connected to Ball & Wood horizontal tandem-compound, four-valve engines. A storage battery was installed in connection with this plant.

Two-wire feeders for lighting were run from the main switchboard to sub-switchboards at the foot of the riser shafts in the several buildings, and a two-wire feeder for power was run to the press-room switchboard controlling the large printing establishment in the basement and first floor of the Northwest Building. Rising feeders extended from the sub-switchboards up the riser shafts to panel-boards located on the various floors. The feeders to the buildings on the south side of Bank Street were run through a tunnel under the street to a subway system in the cellar floor of these buildings. This subway was provided with the necessary manholes and branch conduits to the sub-switchboard locations. This arrangement will be indicated in detail in the following pages.

THE ORIGINAL INSTALLATION.

The initial receiver installation supplied by this equipment consisted of approximately 20,000 16-cp equivalents in lighting and upward of seventy motors the output of which varied from 1 hp to 50 hp. A full description of the plant can be found in the *American Electrician*, January, 1903.

The low-voltage equipment in these buildings, including telephones, annunciators, clocks, dismissal bells and auxiliary equipment of all kinds, was both elaborate and complete. The annunciator system had increased from a small beginning to probably the largest system of its kind in the world. Return calls and registering devices had been employed in all connections between buildings, and, in important cases, between desks on different floors in the same building. The annunciators on the desks of the different officials had become so large that lamp signals and combined lamp and push-button devices had been resorted to, with relays in the spaces behind the drawers especially arranged for in the desk construction. The annunciators of this class were as a general thing placed in one of the desk drawers.

As most desks were free standing, and as moving of individuals, departments and divisions was frequent, the difficulty of maintaining such a system can be readily imagined. Where the various departments were moved from one building to another, as was frequently required on account of the increase in business, it was necessary often to remove hundreds of annunciator and telephone connections, with the connections for lamps with which almost all of the desks are equipped, and in consequence great expense was incurred. These changes were

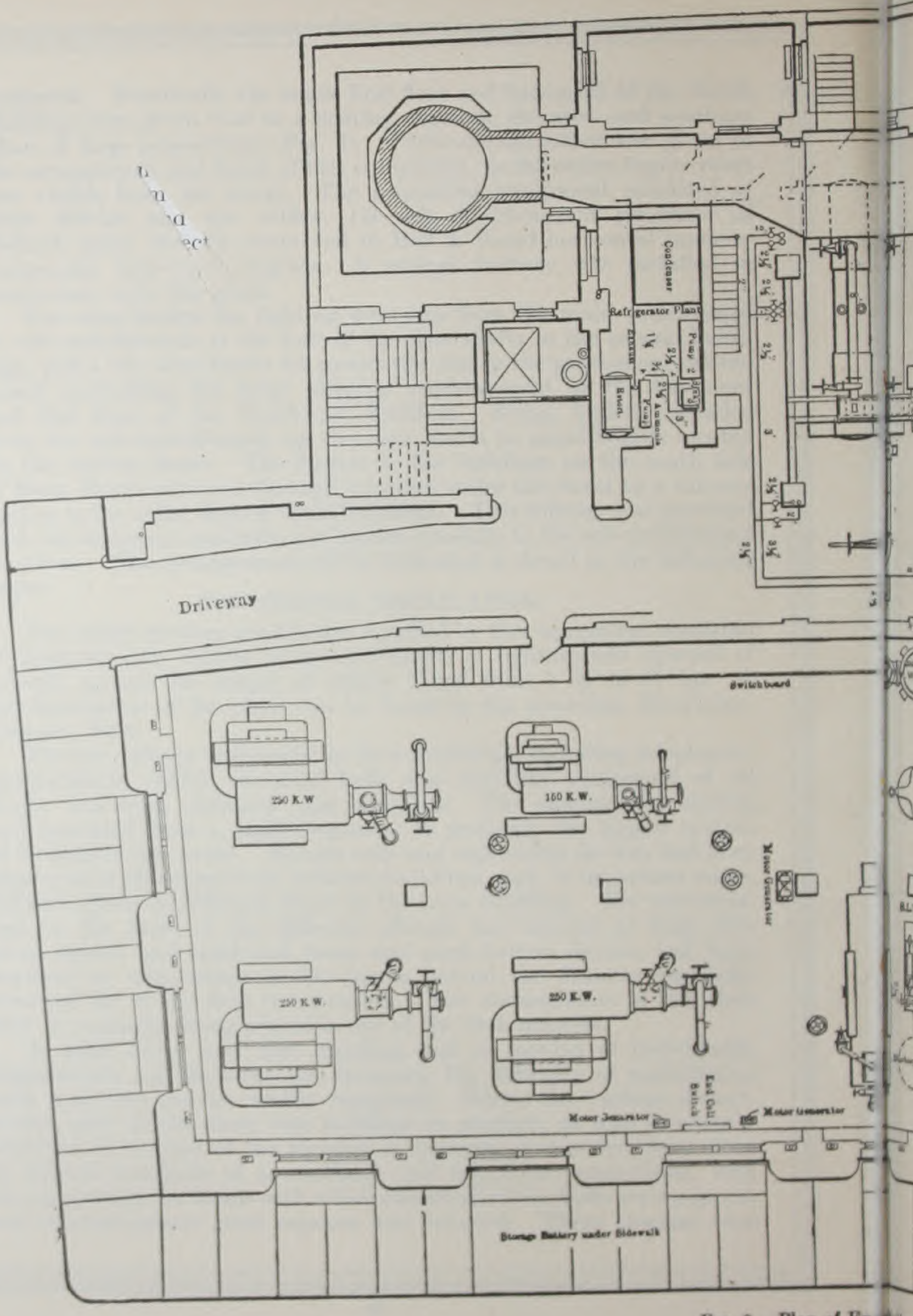
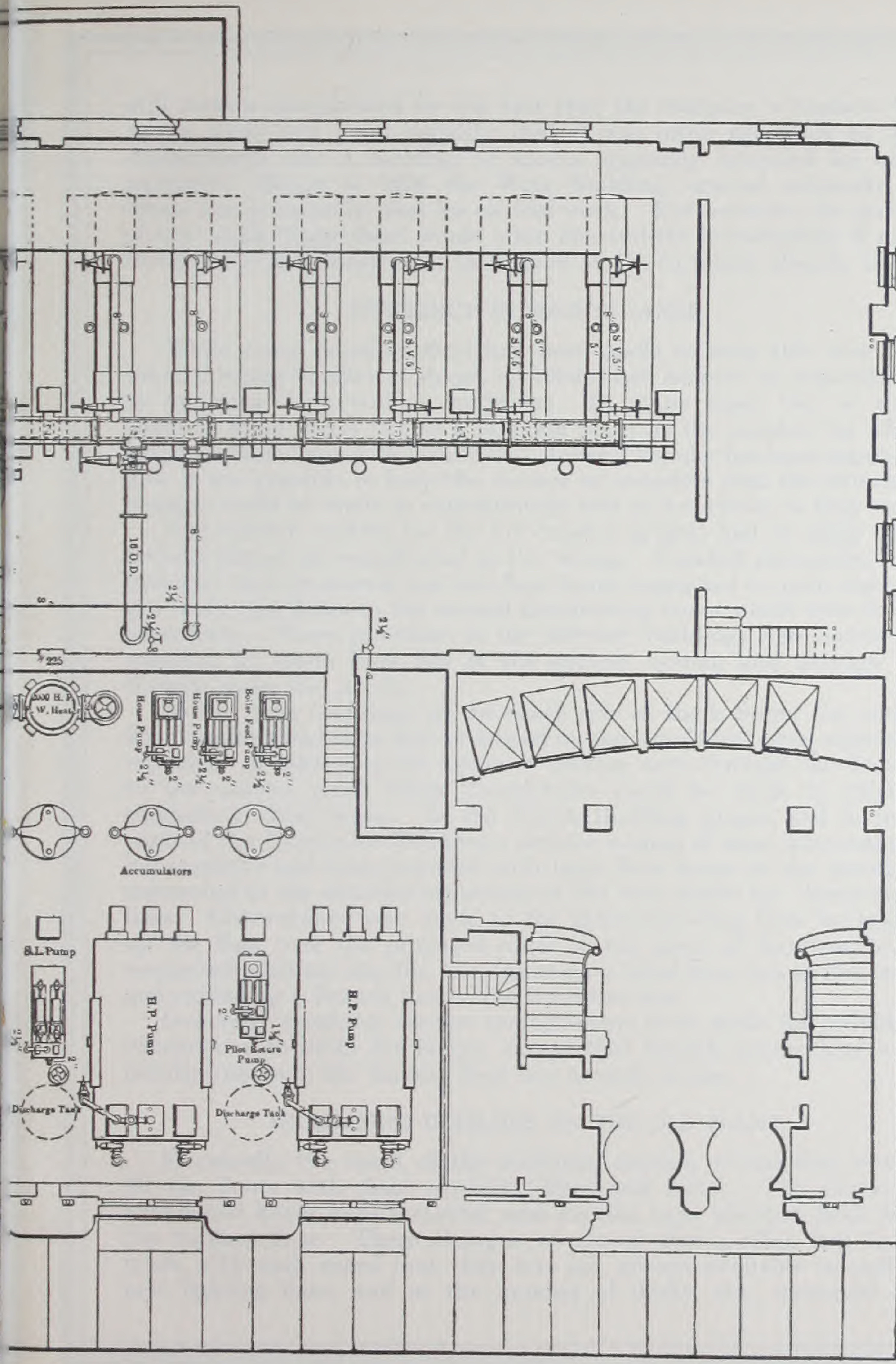


Fig. 2.—Plan of En



...oiler Rooms in 1903.

still further complicated by the fact that the company's business had grown with such great rapidity that it was often necessary to send departments into a building or spaces originally intended for other purposes. Hence in 1909 the West Building, erected originally for filing, was principally used for clerical work. Furthermore, the growth of any single department would often demand the introduction of more furniture, with a consequent shifting of all the furniture already in use.

EFFICIENCY IN MAINTENANCE.

While every possible effort had been made to keep this enormous mass of wiring in efficient shape, by 1909 it had become an impossibility to maintain workmanlike conditions. In many cases two or three times as many wires ran to a junction point as the number for which it was possible to provide terminals. Indeed, wonder has been expressed how it was possible to keep the records so complete that the numerous changes could be made as expeditiously and as accurately as they were.

The conduit system for the low-tension system had in many cases become almost as complicated as the wiring. Conduit extensions from furniture were in general run into floor boxes connected to main conduits run under the floors to the several distributing boxes which were in the basements. These junctions in the different buildings were connected together by trunk lines run in the subway system and through the tunnels under the streets.

In the older buildings on the south side of Bank Street the underfloor conduits had been laid as needed by the simple but often expensive expedient of taking up the floors or cutting slots through the flooring to the nearest point where connections could be made to existing conduits or floor boxes. In the North Building proper and in some parts of the Northwest Building a definite system of large interconnecting conduits had been installed with large floor boxes at the junctions connected to the distributing points at the riser shafts by "home-run" lines. Connections were made to the interconnecting lines by taking up the floor over the proposed route to the piece of furniture to be connected, cutting into the line, inserting a blind floor box at this point and extending a branch line to the furniture box.

Generally speaking, similar arrangements were made for providing connections to desks for lamps, except that branch connections were usually run from the nearest floor box already in use.

INCREASING DEMANDS ON THE OLD PLANT.

Eventually the result of the continual moving of furniture was to fill the floors with dead conduits, lines and boxes. The covers of abandoned boxes were removed, and wooden caps inserted flush with the finished floor. These changes, as stated above, often had to be made with such speed that time was not always available to pull in new lighting lines, and as the number of desks, etc., increased the

circuits available were used to such an extent as to make further extensions dangerous. The wiring was mapped out before the revisions were undertaken, with a view to finding how much of the old wiring could be used in the new work.

It should be noted, however, that the original installation would have been ample had it been possible to use the various floors for the purpose originally intended, and had not the growth of the company's business been so much greater than could have been anticipated. These general remarks are made to explain the conditions existing when work was begun on the North Building additions and to indicate the reasons for certain features of the new installation and of the remodeling of the old distributing system.

PRELIMINARY STUDIES FOR THE NEW INSTALLATION.

The new system was primarily intended to be so arranged that any reasonable extensions and changes could be made at a minumum cost. Records of the cost of making such changes and extensions in the past indicated that it was best to install a system of even relatively high first cost for the purpose of securing maximum convenience both in amount and character of service provided and in the ease and rapidity with which extensions and changes could be made, and to remove all abandoned work, provided such a system would be the cheapest in the end. After much study it was therefore decided to install distributing systems for lamp and motor service and for low-tension work consisting of a complete system of primary distribution that would take care of the maximum possible service at all points, and an exceedingly flexible system of secondary distribution. A study of the history of the existing installation indicated that, while such a primary system might seem large and expensive over a considerable part of the proposed installation, yet there was every likelihood that the demands made upon any part of it might at very short notice rise to the maximum.

Thus it was proposed that certain sections of floors which were intended for filing cabinets should be equipped with empty conduits in the same manner as the most heavily loaded section on any floor, so that any change in the character of the furniture used in these sections could be arranged for without any extensive alterations. The result was the equipment of all floors in a similar manner for the maximum conditions so far as the main centers of distribution were concerned and also the equipment of every floor alike with a secondary distribution system so far as conduits and sub-distribution centers were concerned, but to wire up the secondary system to meet only the actual conditions existing at the time of installation. The wisdom of this decision has already been demonstrated.

The conditions imposed therefore generally barred precedent in the design of the equipment. In many cases new and radical departures from the usual methods of wiring had to be considered and new standards of construction evolved.

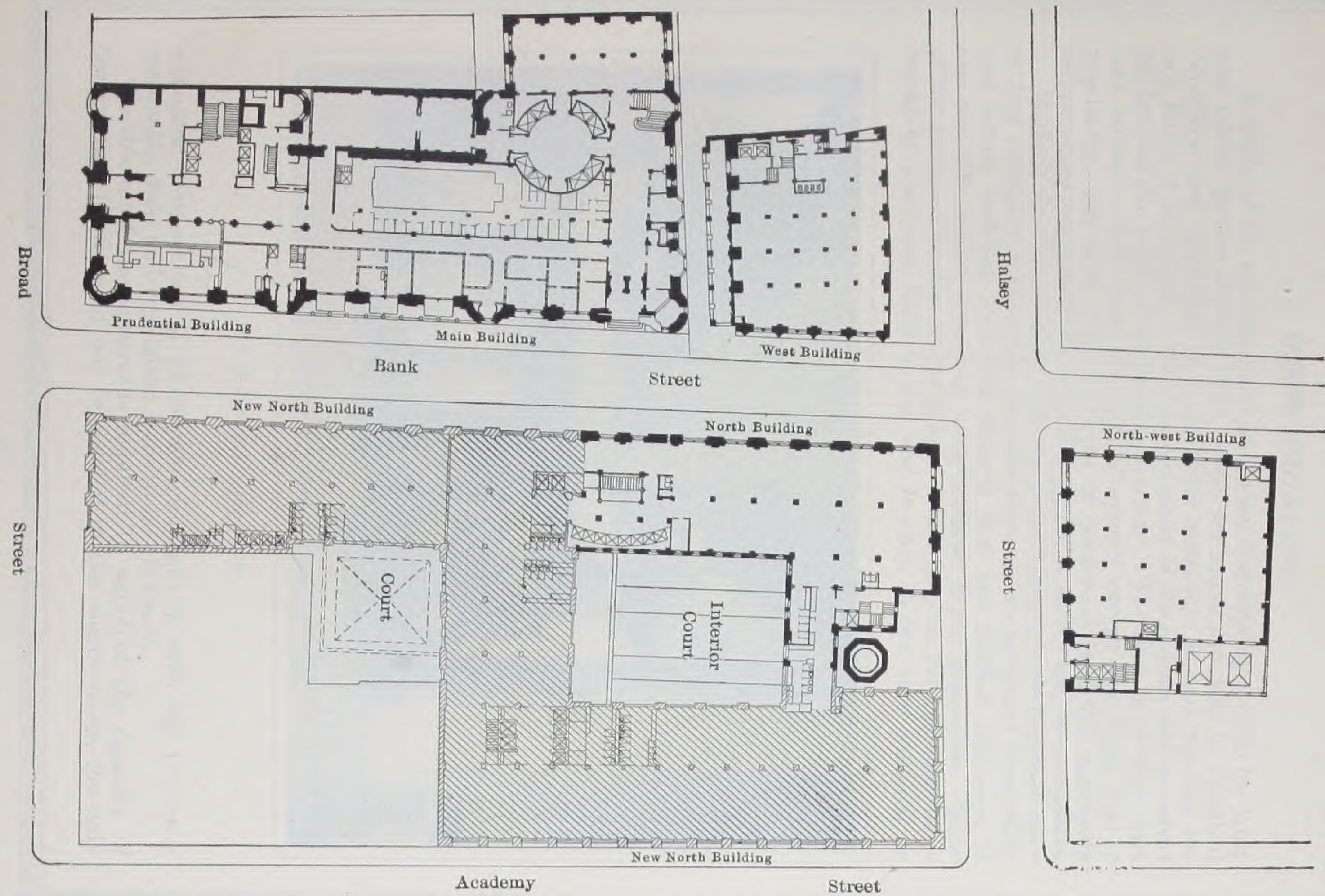


Fig. 3.—General Plan of the Buildings of Prudential Insurance Company

FEEDER LIMITATIONS.

A study of the existing plant and main distributing system for lamp and motor service showed that, while the apparatus was in excellent condition and operating at remarkable economy, it had reached the safe limits of its output. The load on many of the feeders had increased far beyond the point of maximum economy. The drop in several cases was excessive both from the view of wasted energy and from that of regulation. On some lines at times of maximum load the maximum temperature rise permissible with due regard to safety had been reached.

While it was thus evident that the distributing system required more or less extensive remodeling, consideration of the proposed immediate and future building activities showed that any further extension of the two-wire system would be uneconomical, if not impossible. Some of the groups of feeders to the proposed buildings on the two-wire basis would be enormous both in size and in cost, in one case reaching an

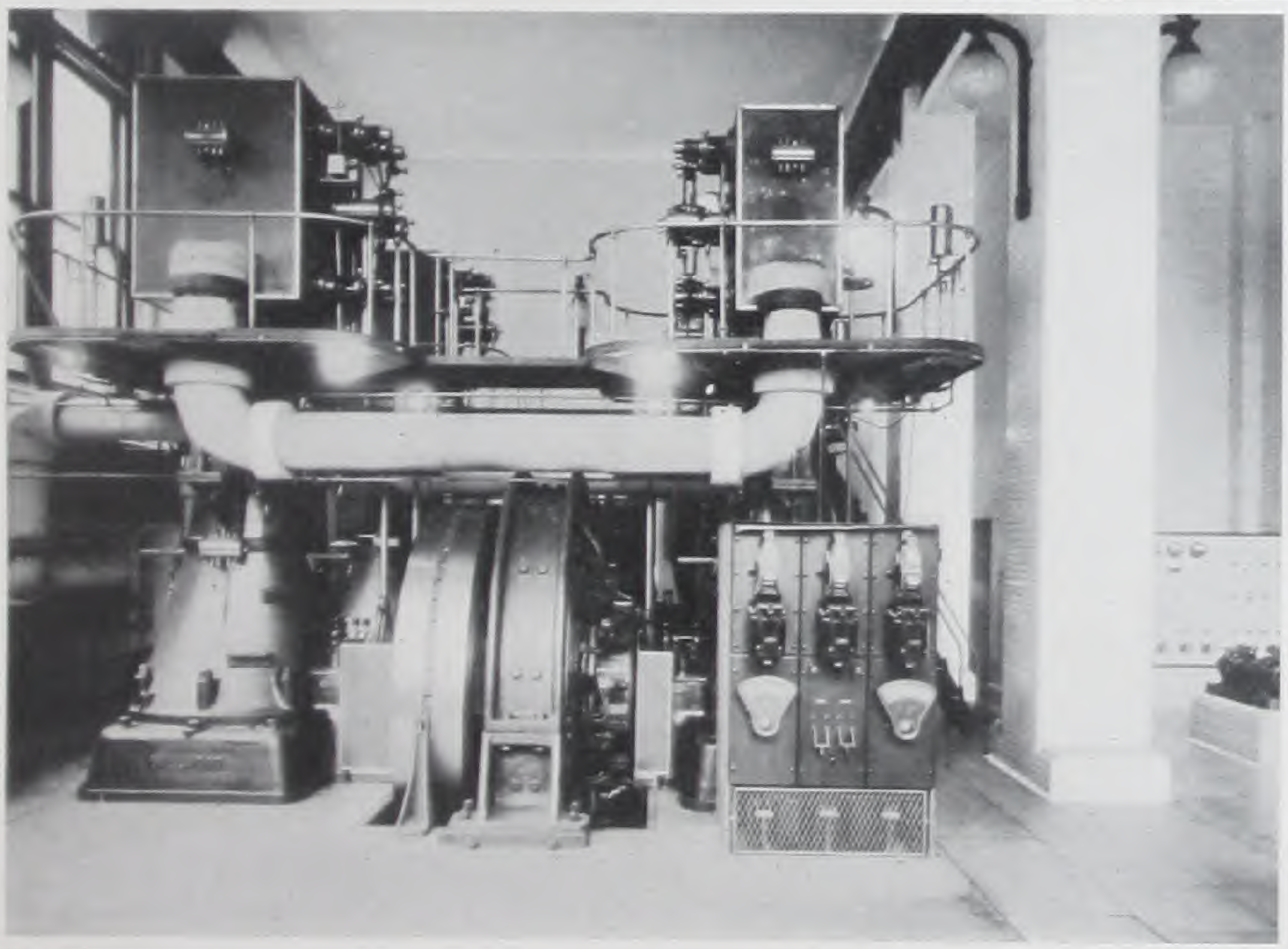


Fig. 5.—New Engine Room.

estimated cross-section of 72,000,000 circ. mils in each leg, if even a reasonable drop and regulation were to be obtained.

Furthermore, the apparatus required to augment the capacity of the existing plant could not be located in the engine-room, the only

space available being the west corner of the first floor and basement of the North Building addition, a condition that meant the separation of the new and the old engine-rooms by the combined widths of the new and old boiler-rooms (Fig. 5).

SWITCHBOARD LIMITATION.

Since the existing switchboard was considerably north of the electrical load center of the entire group of buildings, both present and proposed, it did not seem wise to move it any further north, even though the largest portion of the final generating plant had to be in the north engine-room. This situation produced the interesting condition of an ultimate additional generating equipment rating of 1500-kw nearly 200 circuit ft. from the switchboard and the existing equipment of 800-kw at an average electrical distance of 45 ft. Hence, if each machine was to be separately connected to the board in the usual way, the aggregate of the generator leads would be very great.

The existing switchboard was approximately 37 ft. long. To add to it sufficiently to handle the new units and also the feeder controls for new and proposed buildings would have increased its length to 80

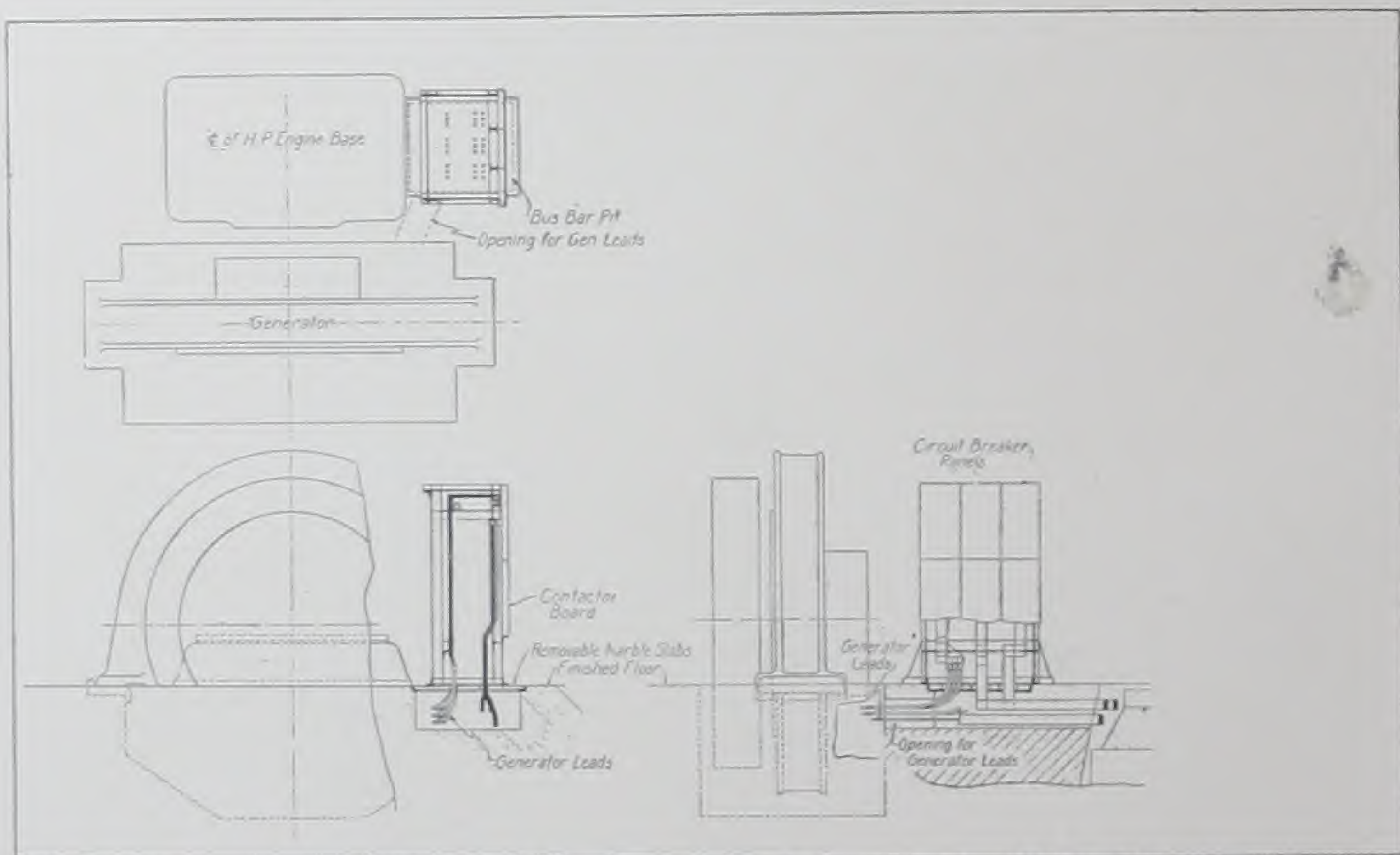


Fig. 6.—Generator Contactor Board in New Engine Room.

ft., making it unwieldy and also rendering it necessary to rebuild the board so as to place all feeder switches on a gallery. Investigation showed, however, that it was impossible to obtain space for the multiplicity of heavy leads and feeders in the cellar or passageway of the old building. In other words, even had it seemed advisable to rebuild the old switchboard, rather than abandon it, it would have been impossible

to bring the necessary connections to it. These and numerous other considerations of a practical nature indicated that it was best to recommend placing the entire equipment, both old and new, on a 120–240-volt, three-wire basis, to abandon the old switchboard and arrange for the remote-control method of operating the electrical plant and distributing system, the center of distribution being removed from the old engine-room to a convenient point in the basement of the new building as far east as possible so that the heavy feeders to proposed buildings farthest from the plant would be correspondingly shortened.

This work has been carried out and the entire distributing system for the low-tension work remodeled without interruption of the service. No one outside of the engine-room force was aware of the time the change-over occurred. It is interesting to express the belief, in passing, that the Prudential Buildings possess the first remote-control switchboard designed for a direct-current plant.

THE NEW GENERATORS.

In order to provide for the immediate increase in the load and to relieve the old plant it was considered advisable to install at once two

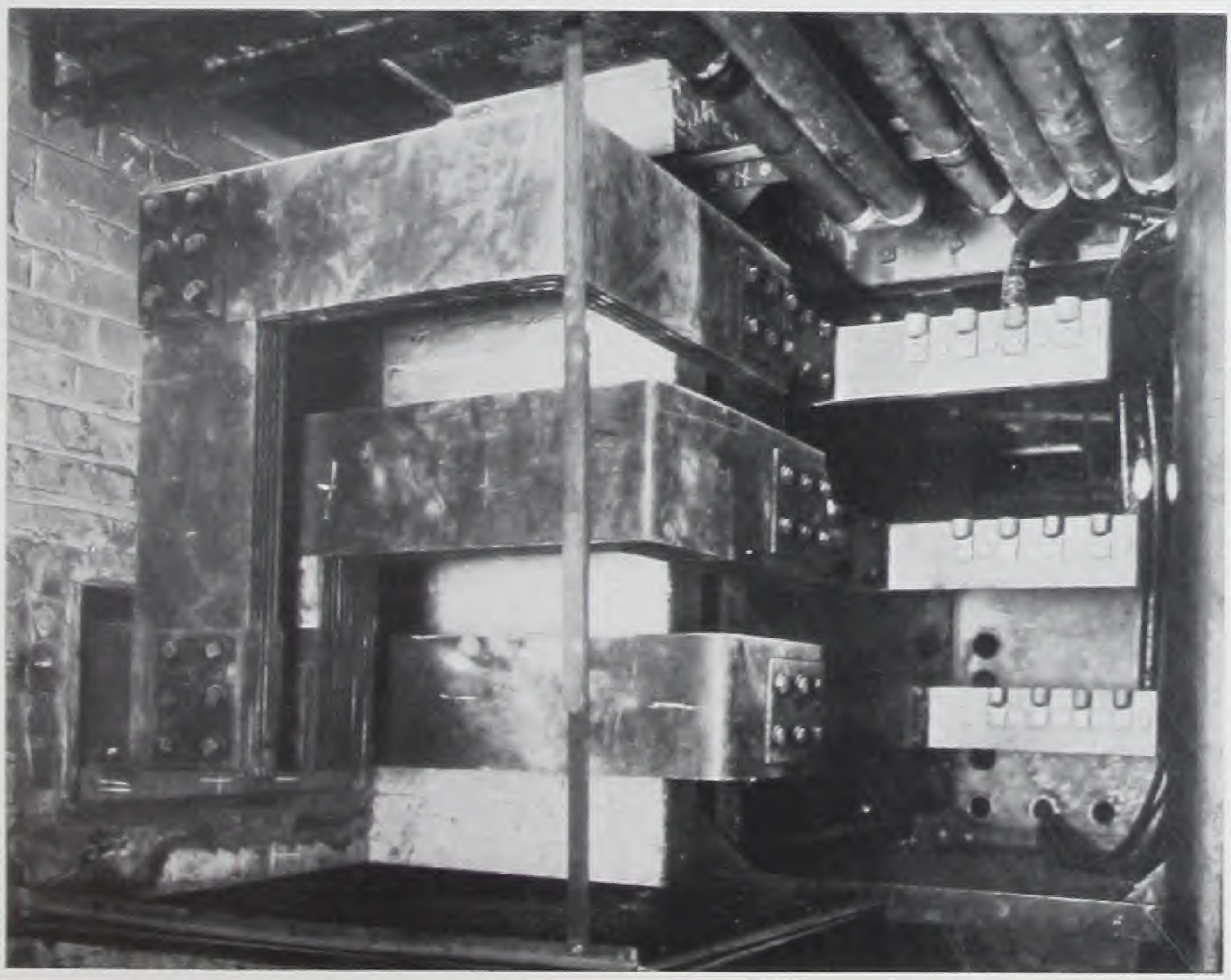


FIG. 7.—Bus Detail, Old Engine Room Junction.

500-kw generators with space in the new engine-room for a future unit of the same rating. Space conditions required the used of vertical engines; economical operation required that they be compound. Fig. 5 shows a view of the new engine-room.

The 500-kw units rest on a monolithic foundation of concrete reinforced with a grillage of I-beam in three tiers. The generator pits are lined with sheet steel, the pans being set on brick piers, weighted down, and the concrete poured around them.

The generators are of Sprague Electric Company's make, and operate normally at 150 r.p.m., with 235 volts at no load and over-compound 5 volts from no load to full load. They are built on 800-kw frames and show a test temperature rise in the windings of 29 deg. C. by thermometer after four hours' run at 25 per cent overload, succeeding a full-load run for eight hours. The engines are of Ball & Wood make

Fig. 8.—Main Generator Busbars. New Engine Room.

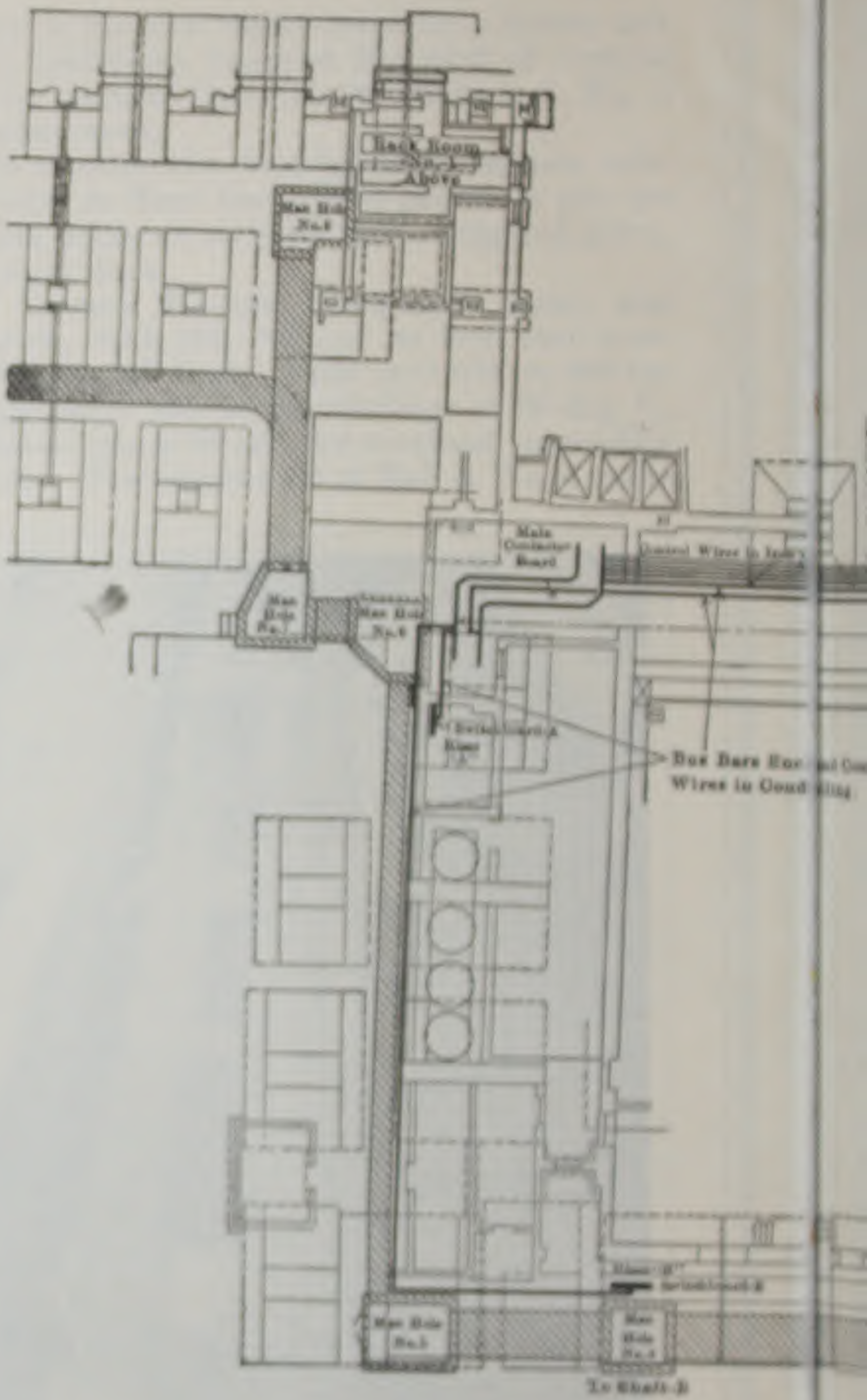
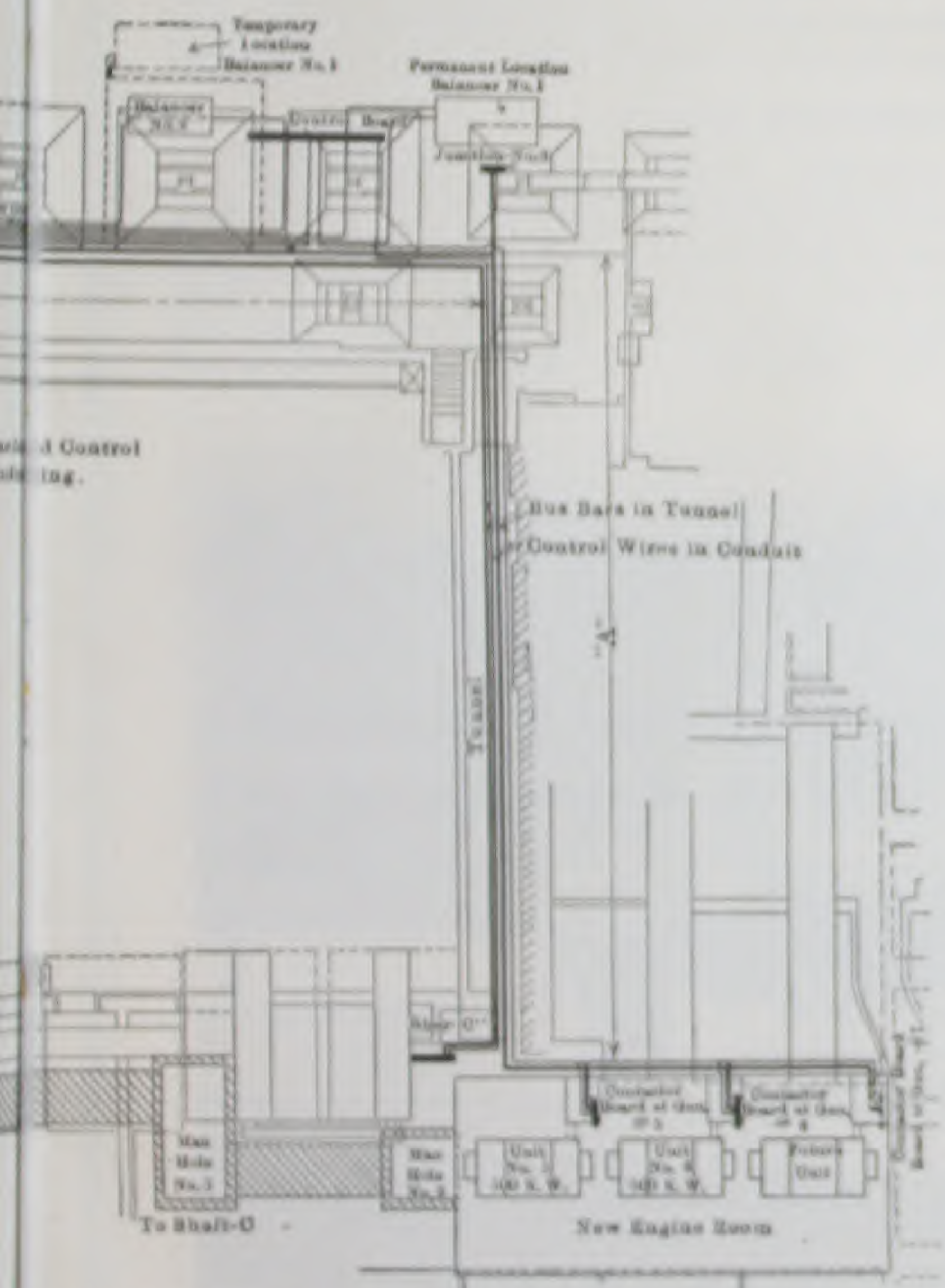


Fig. 9.—New Gener



nd Busbar Layout.

of the cross-compound type. Owing to the cramped space conditions in this room lengthwise of the shafts it was impossible to provide for proper and accessible generator terminal boards in the generator pits, and hence the armature flexible leads and the series field-coil connections are brought directly to the generator contactor board, as shown in Fig. 6, on the rear of which is mounted the series field-circuit shunt. Thus the board serves the double duty of a generator terminal board and a generator switchboard panel. On this board are mounted three solenoid-operated single-pole switches, positive, negative and equalizer, respectively, the negative switch being provided with an overload coil and all three electrically interlocked. An ammeter and a voltmeter were also provided on each of these boards, both instruments being duplicated on the control board in the old engine-room on Bank Street.

BUSBAR EQUIPMENT.

The busbars on the generator contactor boards extend down into a pit below the board and there connect directly to the main generator busbars, which are run in a deep trench at one side of the engine foundations. These busbars in course of construction are shown in Fig. 8, the view corresponding to the position marked X in Fig. 11. They are supported on structural steel bents with soapstone seats.

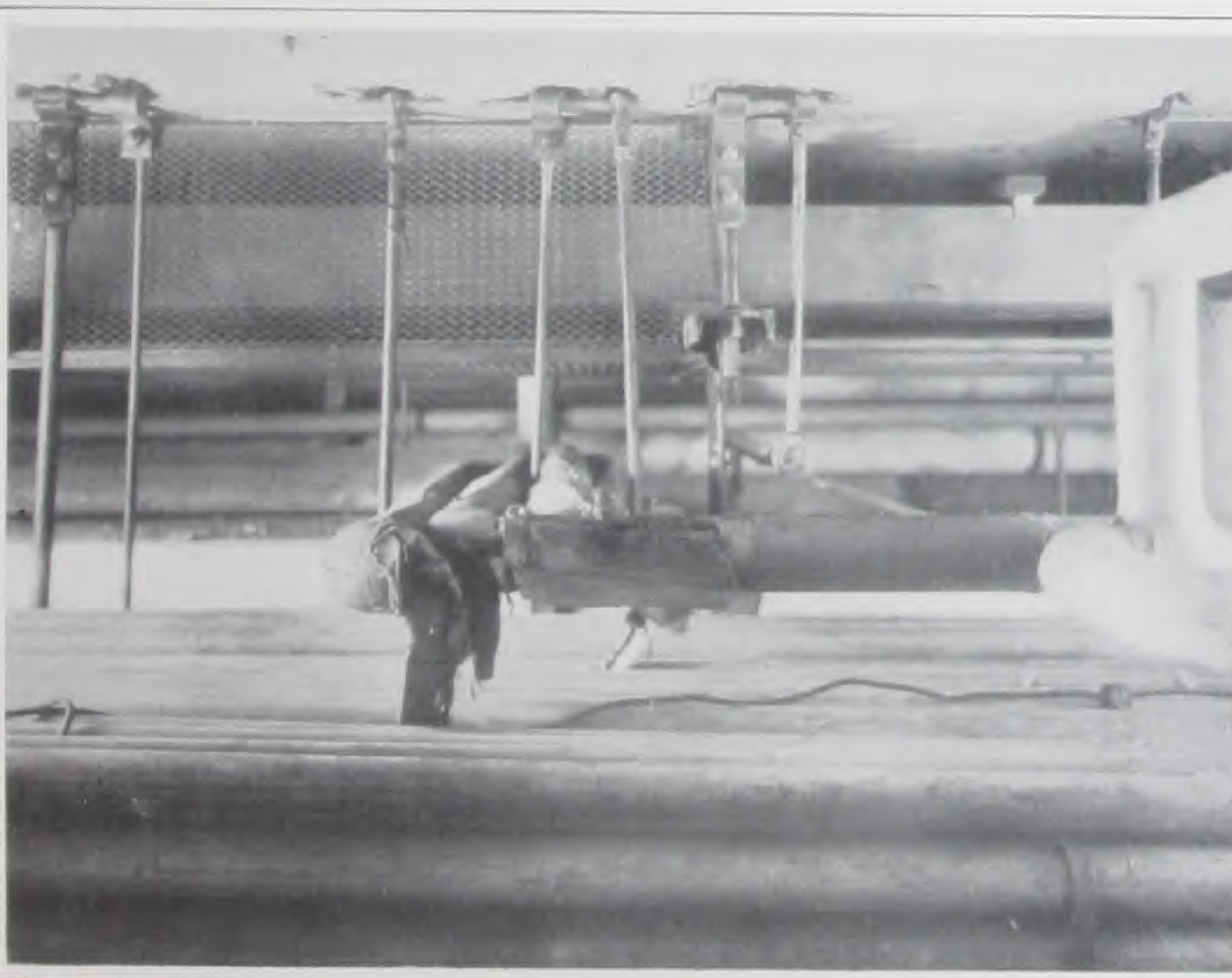


Fig. 10.—Detail of Main Bus.

At the east end of the engine-room the generator buses, together with the conduits containing control lines, ammeter leads and pressure wires, enter a tunnel through which they extend to the passage under the old boiler-room floor in the old building. Here they rise to the ceiling of this passage and connect with the busbar leads from the old generators in the old plant.

From this point the positive and negative buses extend easterly along the ceiling of the passage to the contactor-board room. Fig. 9 shows the general route of these busbars. That portion of the busbars marked *A* in Fig. 9 is shown on a large scale in Fig. 11, both plan and elevation, and that portion marked *B* in Fig. 9 is similarly shown in Fig. 12.

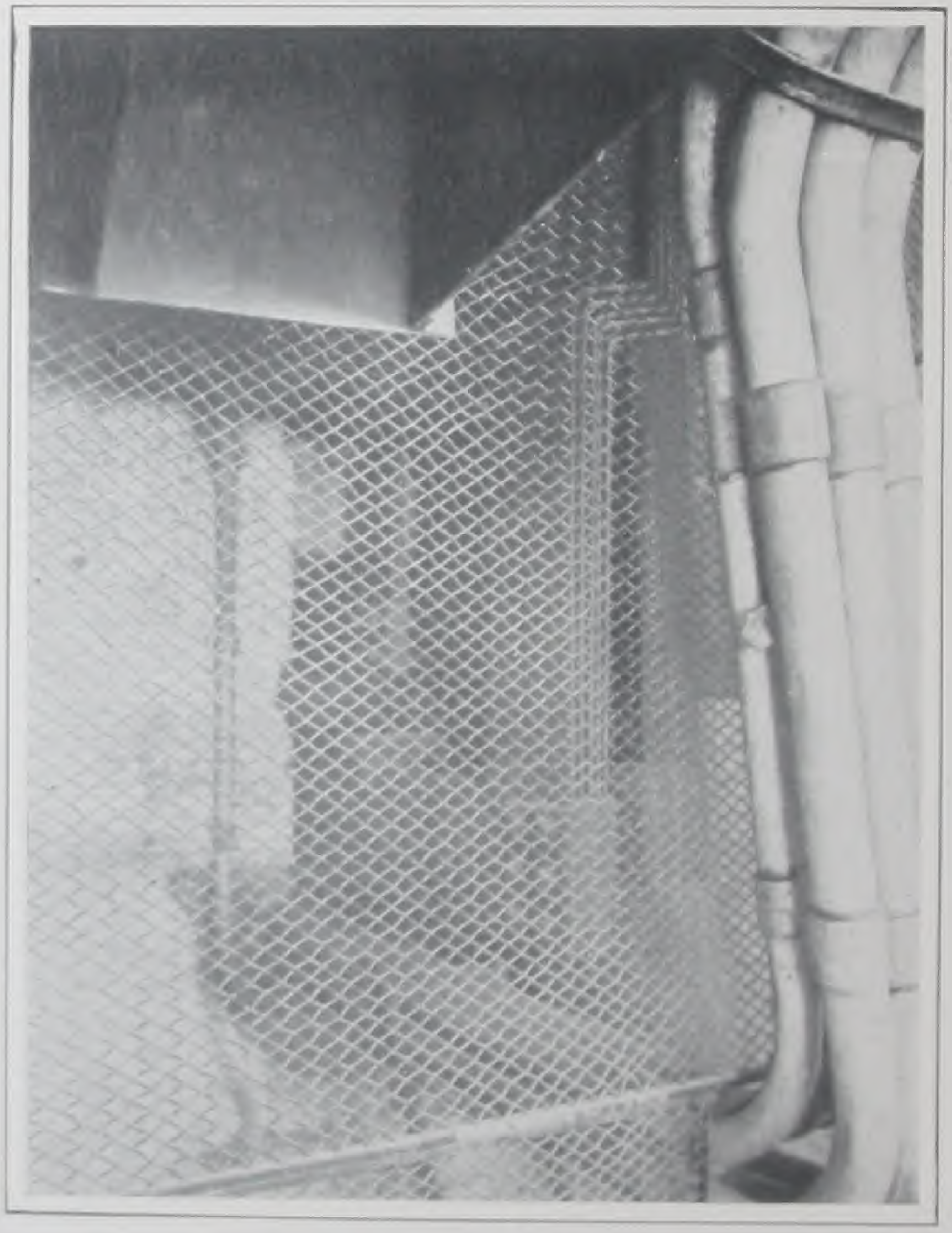


Fig. 13.—Details of Main Bus.

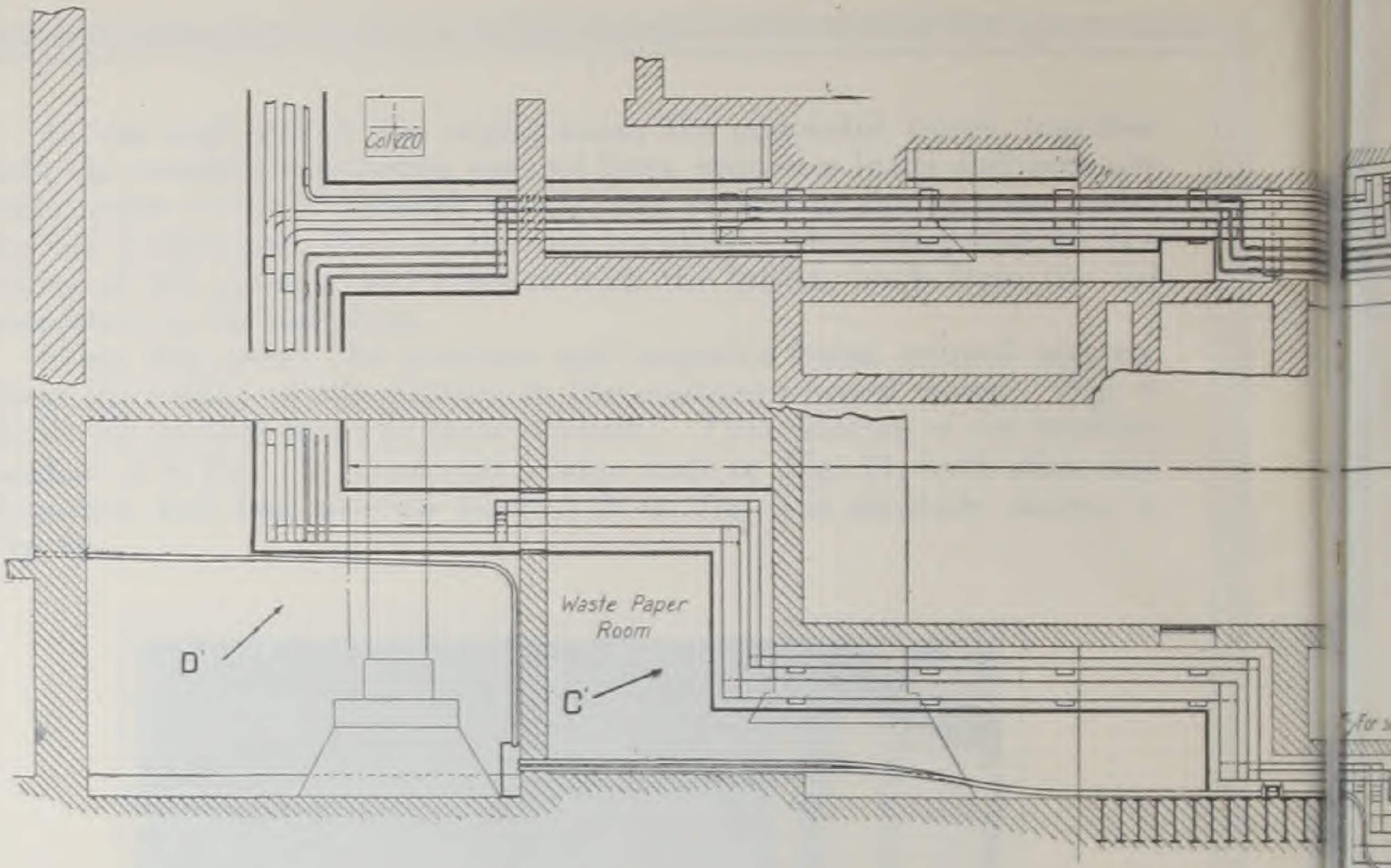


FIG. 11.—Det Main

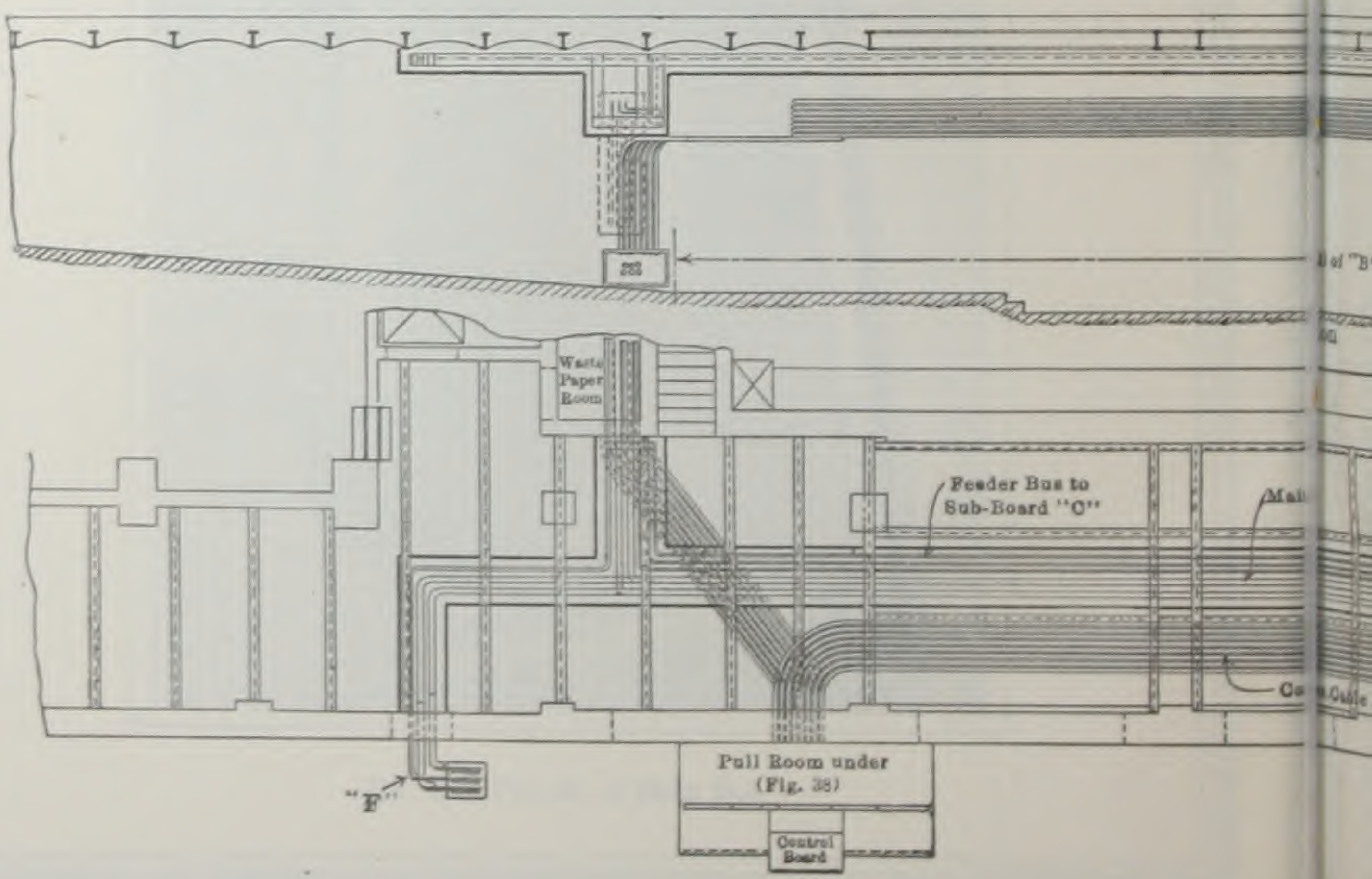
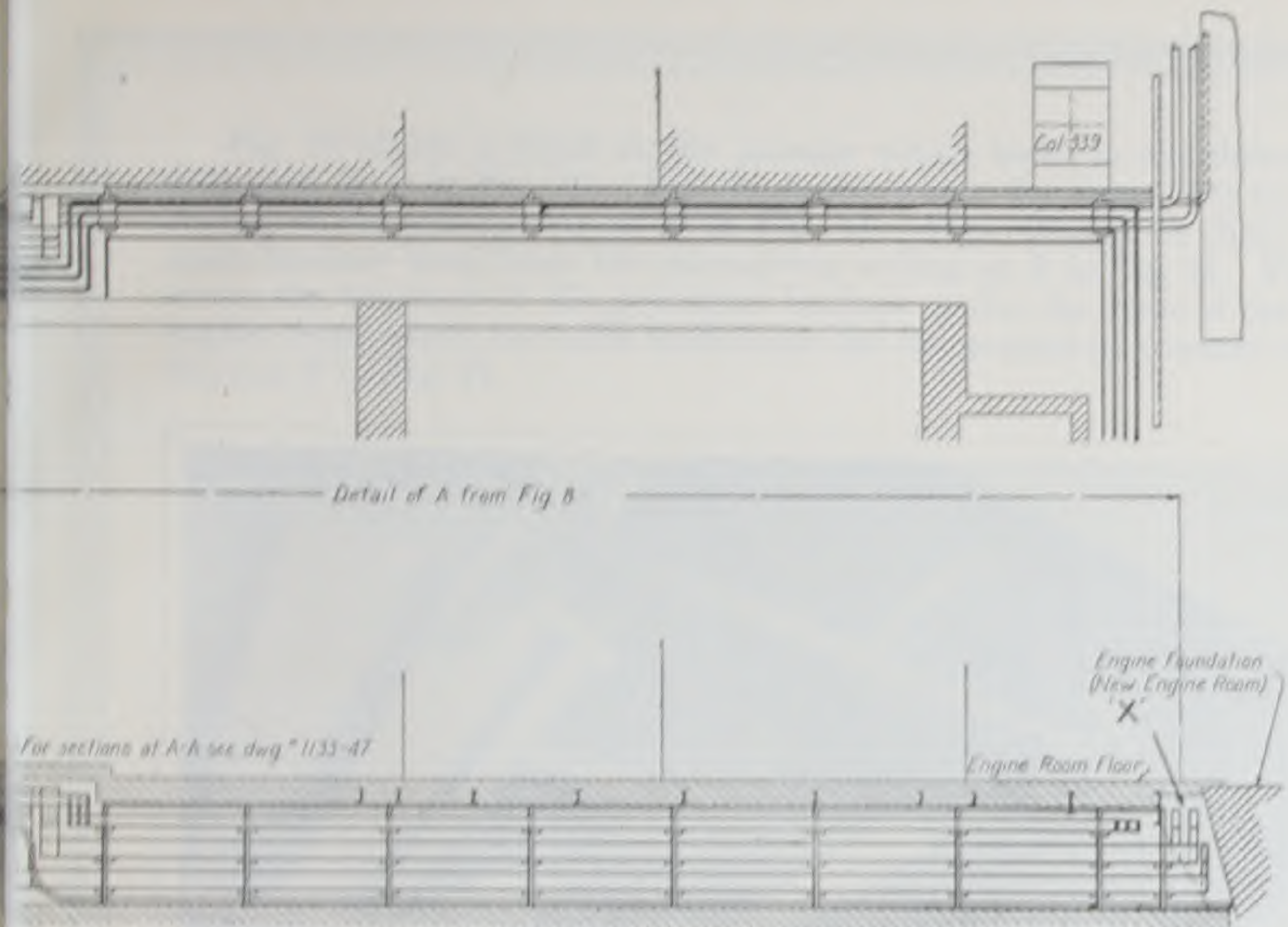
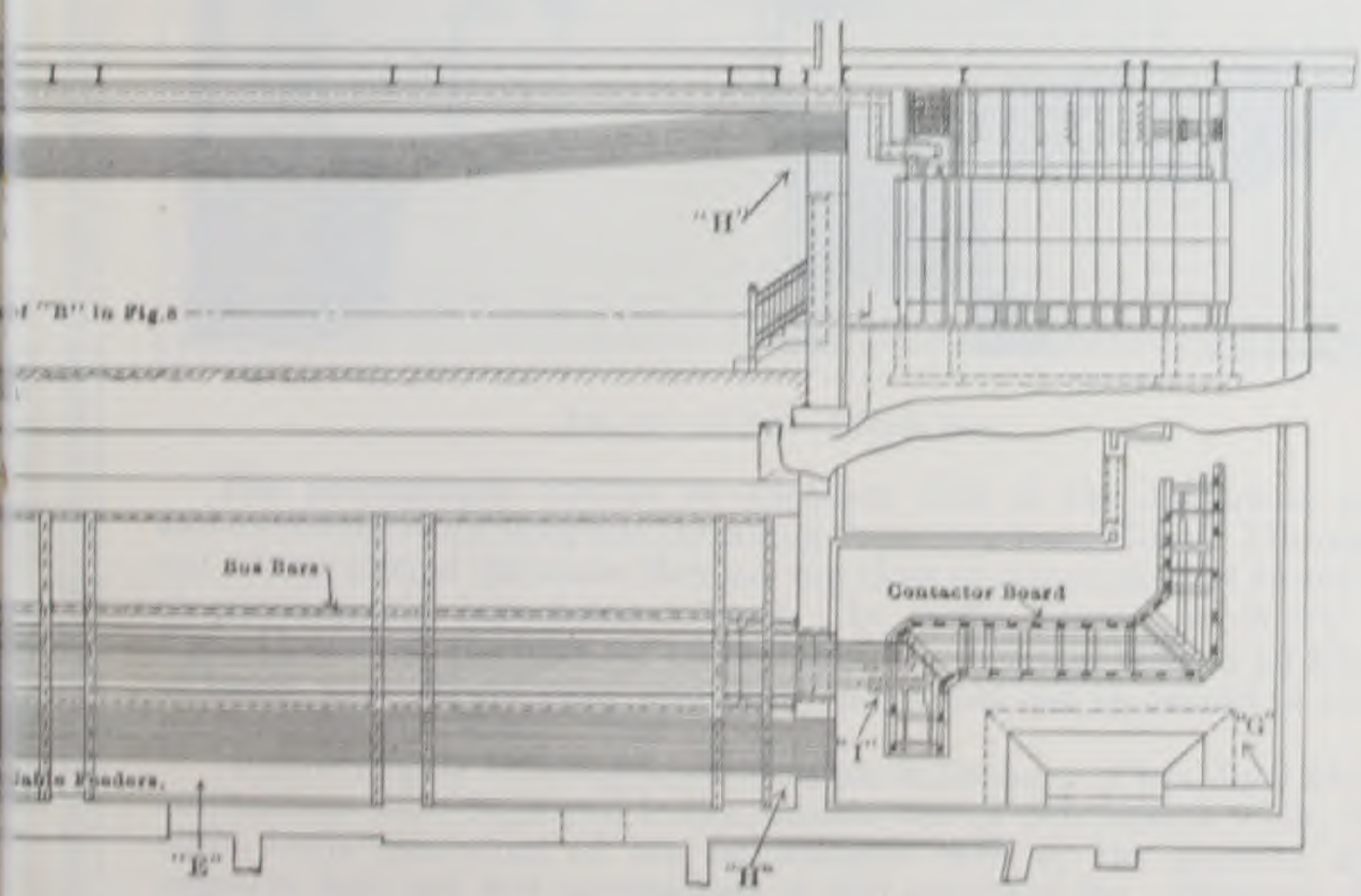


FIG. 12.—De Main



ain Bus.



ain Bus.

Fig. 13 shows a detail in the passage which looks in the direction indicated at C in Fig. 11. Fig. 14 shows where the buses rise to the ceiling of the passageway at D in Fig. 11. Figs. 10 and 15 show the main busbars hung from the passageway ceiling at E in Fig. 12. Fig. 7 shows the terminus of the generator busbars under the floor of the old engine-room where the cable leads from the old generators connect with them at F in Fig. 12.

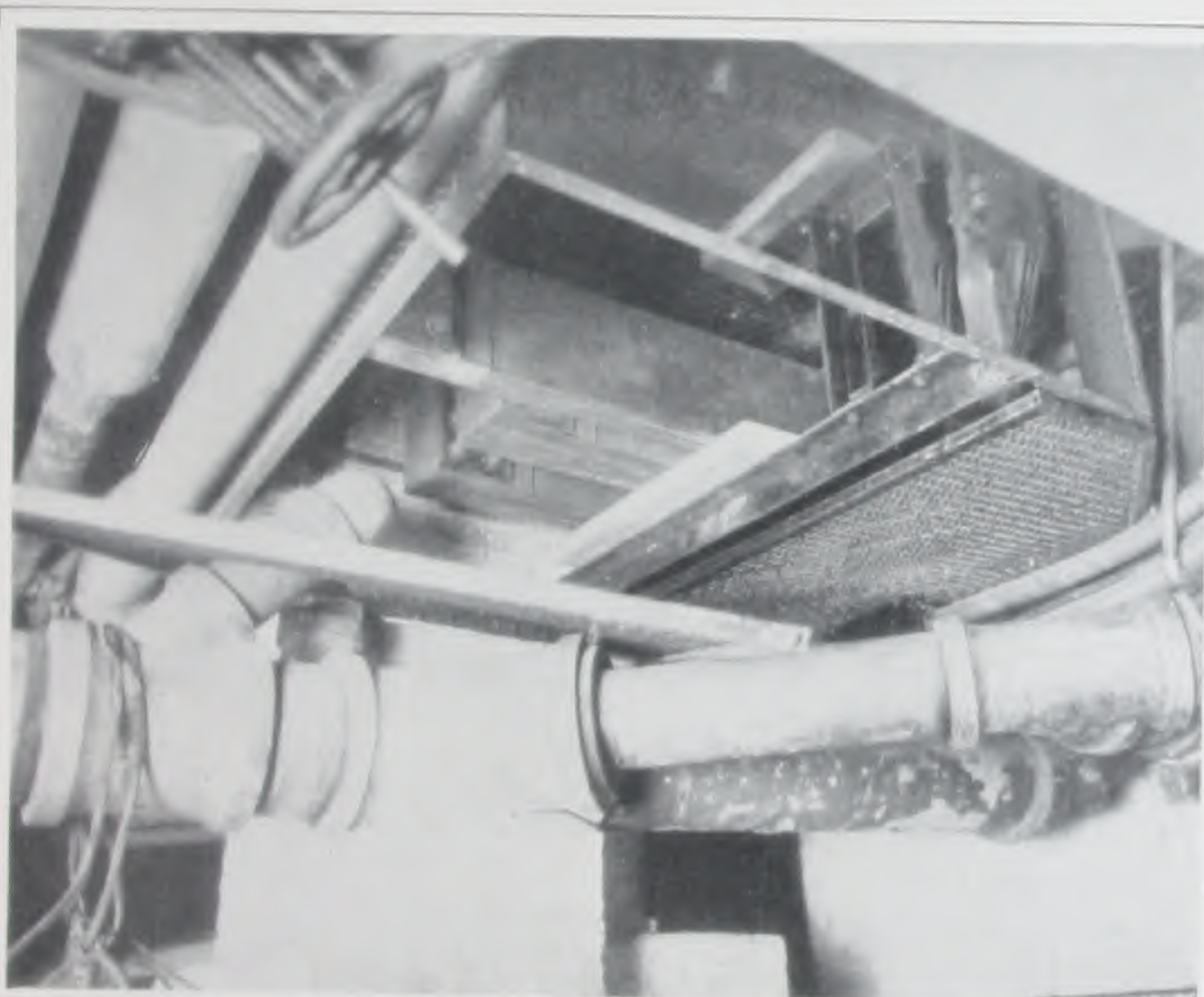


FIG. 14.—Details of Main Bus.

The photographs convey no adequate idea of the difficulties met and overcome in locating and installing these very heavy bars. Throughout a large part of the route they are run close to steam pipes in locations at permanently high temperatures. In many places, as shown in Figs. 11 and 12, the bars are exceedingly tortuous and bent in all kinds of forms to avoid old pipes and ducts that could not be moved or even temporarily shut down.

Approximately 70,000 pounds of copper in the form of 8-in. by 0.25-in. laminations were employed in the construction of this busbar work, the main leads consisting of ten laminations each in the positive and negative legs and five laminations in the equalizer leg. Between the

fishplates and on all supports cast-iron space plates with projecting spacing teeth were employed. A disconnecting switch has since been installed in the busbars in the waste-paper room (see Fig. 12).

The only changes made in the old generator plant were to remove

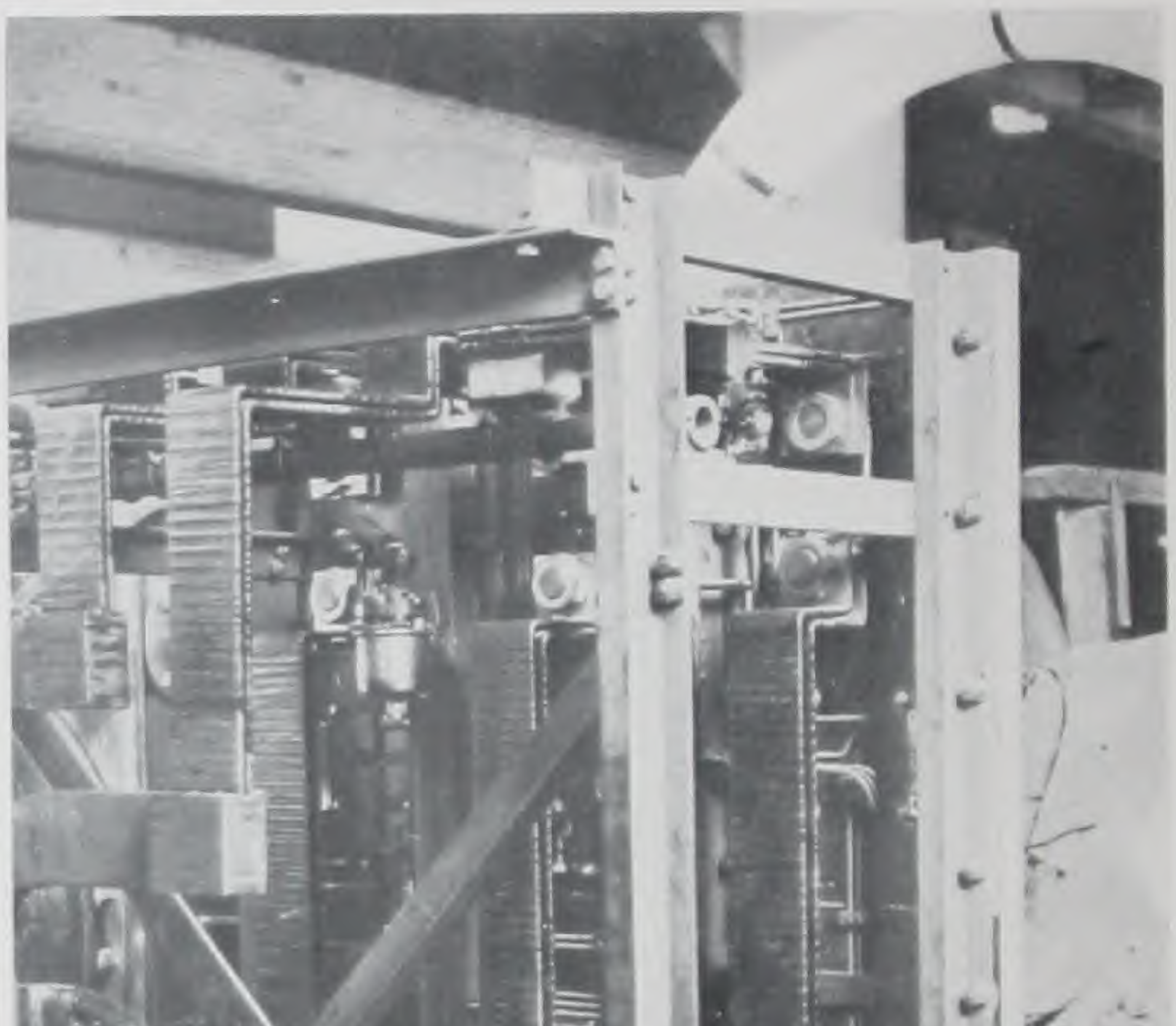


FIG. 16.—Generator Contactor Board.

the old generators and replace them with new 240-volt machines. As in the new plant, each machine was provided with a generator contactor board, the buses on this board being extended to and bolted on the generator terminals. The 250-kw machine contactor panel is shown in Figs. 16, 17 and 18.

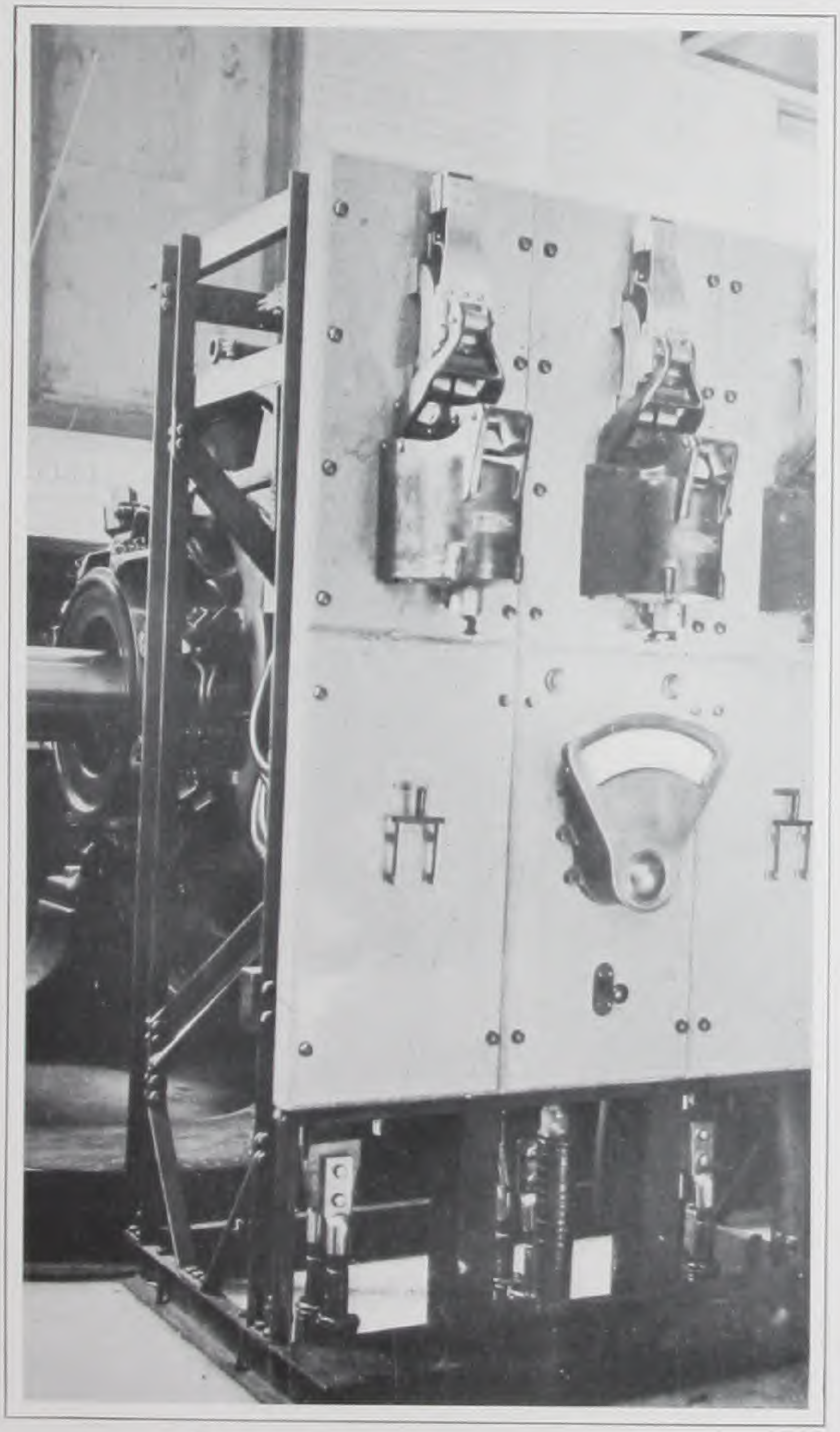


Fig. 17.—Generator Contactor Board.

In order to establish the neutral on the three-wire lighting feeders two balancer sets were installed in the old engine-room. The sets are

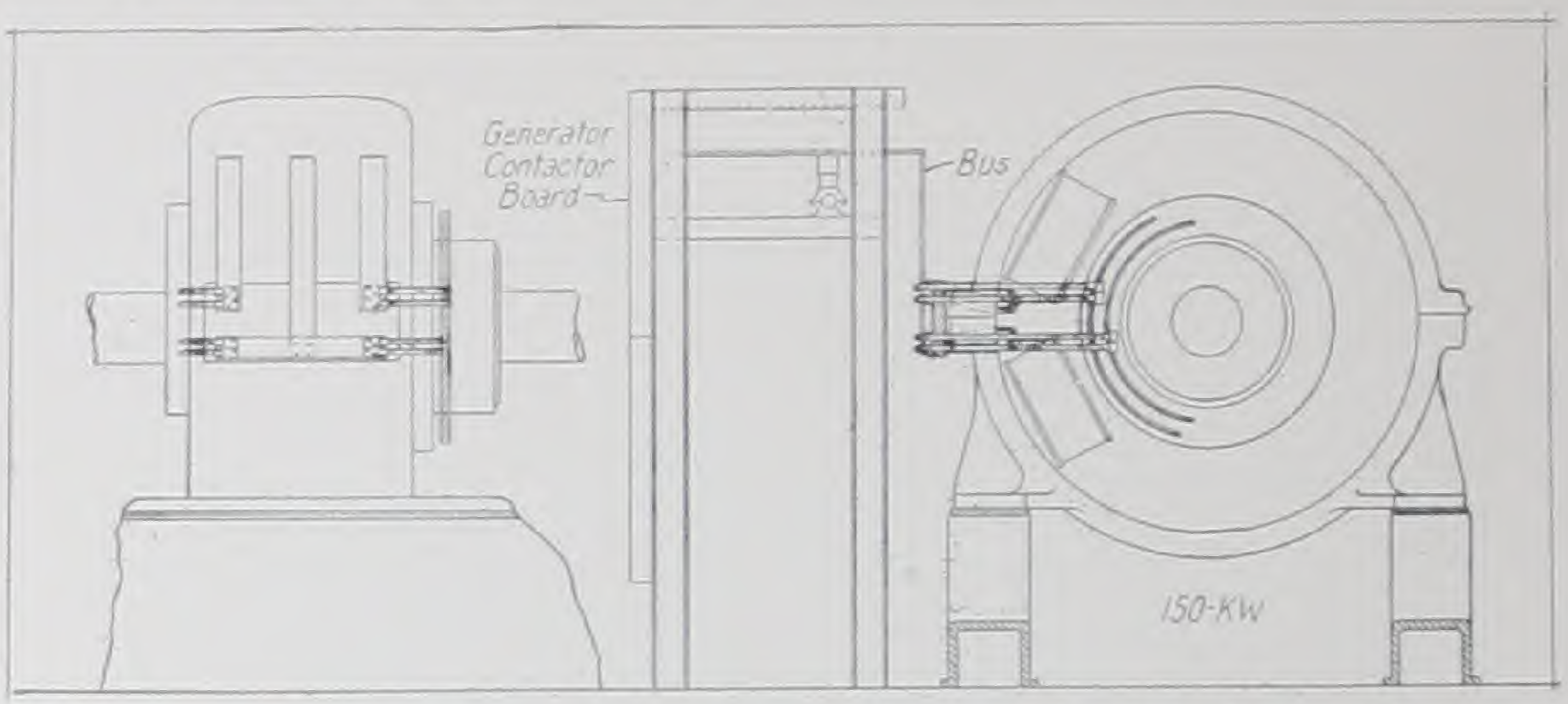


FIG. 18.—Detail of Arrangement of Generator in Old Engine Room.

capable of handling a maximum unbalance of 800 amp. flowing in the neutral; that is, about $12\frac{1}{2}$ per cent of the average maximum of the present load on the plant. The main switchboard for operating this equipment, known as "Switchboard No. 1," consists of three parts: the

FIG. 19.—Control Board, Switchboard No. 1. Showing old switchboard temporarily double-decked during transfer.

control board shown in Fig. 19, the generator contactor boards already described, and the main contactor board shown in Figs. 20, 21 and 22.

REMOTE-CONTROL SWITCHBOARD.

The control board is built of selected gray Tennessee marble, with a blue Vermont marble sanitary base. The instrument cases, rheostat wheels, escutcheons, switches, etc., are finished "old copper." The cornice and columns are of statuary bronze. A copper diffuser with

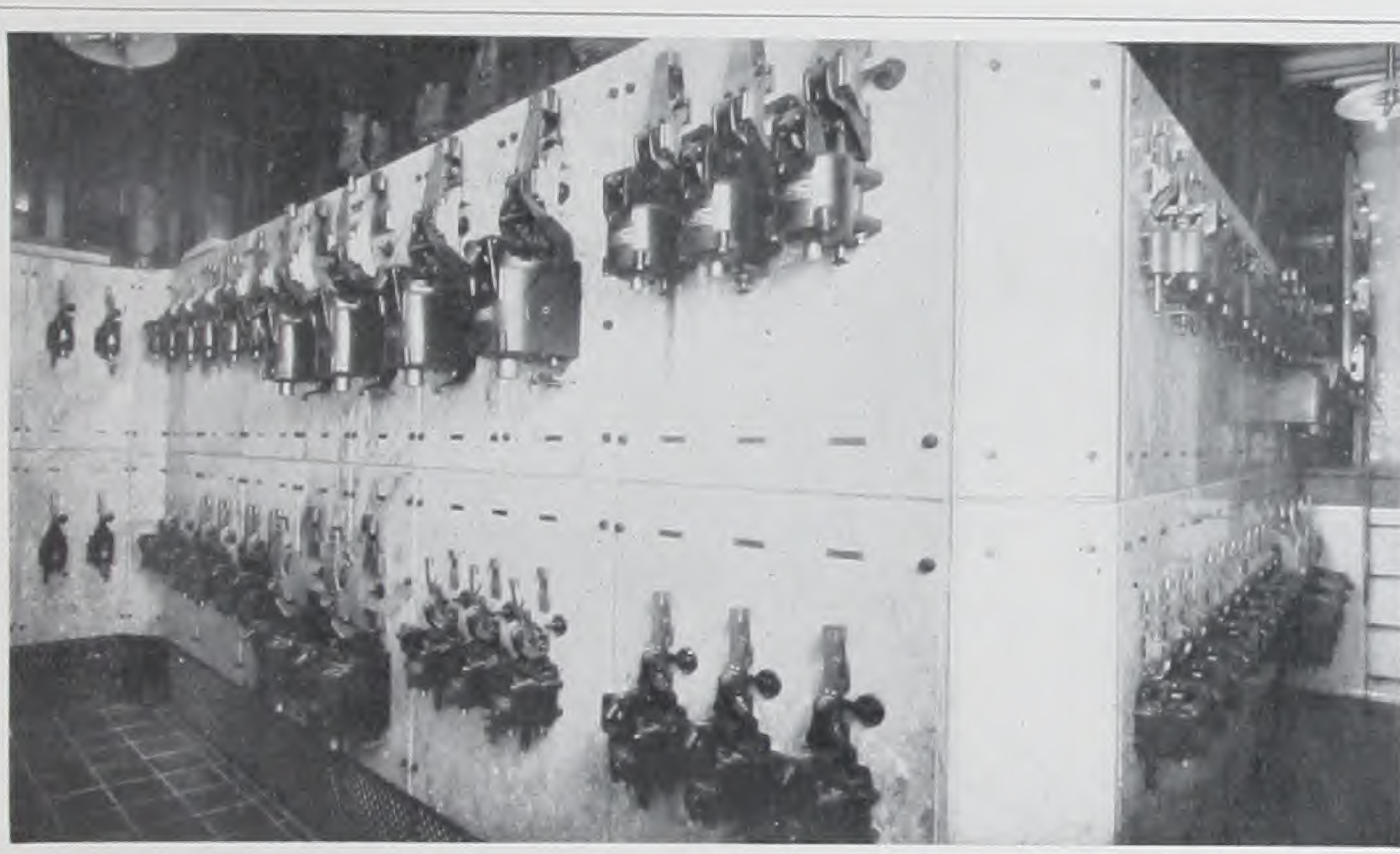


FIG. 20.—Main Contactor Board, Switchboard No. 1.

opal-glass deflector trough is arranged back of the cornice and serves to light the face of the board. Name-plates have reverse etched titles and are finished to match the rest of the metal-work. The instrument panels contain seven generator ammeters, a high-load station ammeter, a low-load station ammeter, main neutral ammeters, a high-load curve-drawing ammeter, a low-load curve-drawing ammeter, a curve-drawing voltmeter, a station voltmeter and a differential double coil voltmeter both on a swinging bracket, and a horizontal edgewise zero-point ammeter connected into the neutral leg of each three-wire feeder. The last-mentioned instruments make it possible for the operator to tell at a glance the amount of unbalance in the feeder to each sub-switch board.

Two horizontal edgewise voltmeters are also provided, each connected to a 20-point voltmeter switch on the operating desk so that pressure readings may be taken at the various sub-switchboards. One point in each switch is so connected that the instruments may be connected

between neutral and outside buses to obtain simultaneous balance voltage readings.

The control switches for operating the contactors on the generator panels and the contactor board are of the pull type mounted on the benchboard. They have combined mechanical and lamp signals, the

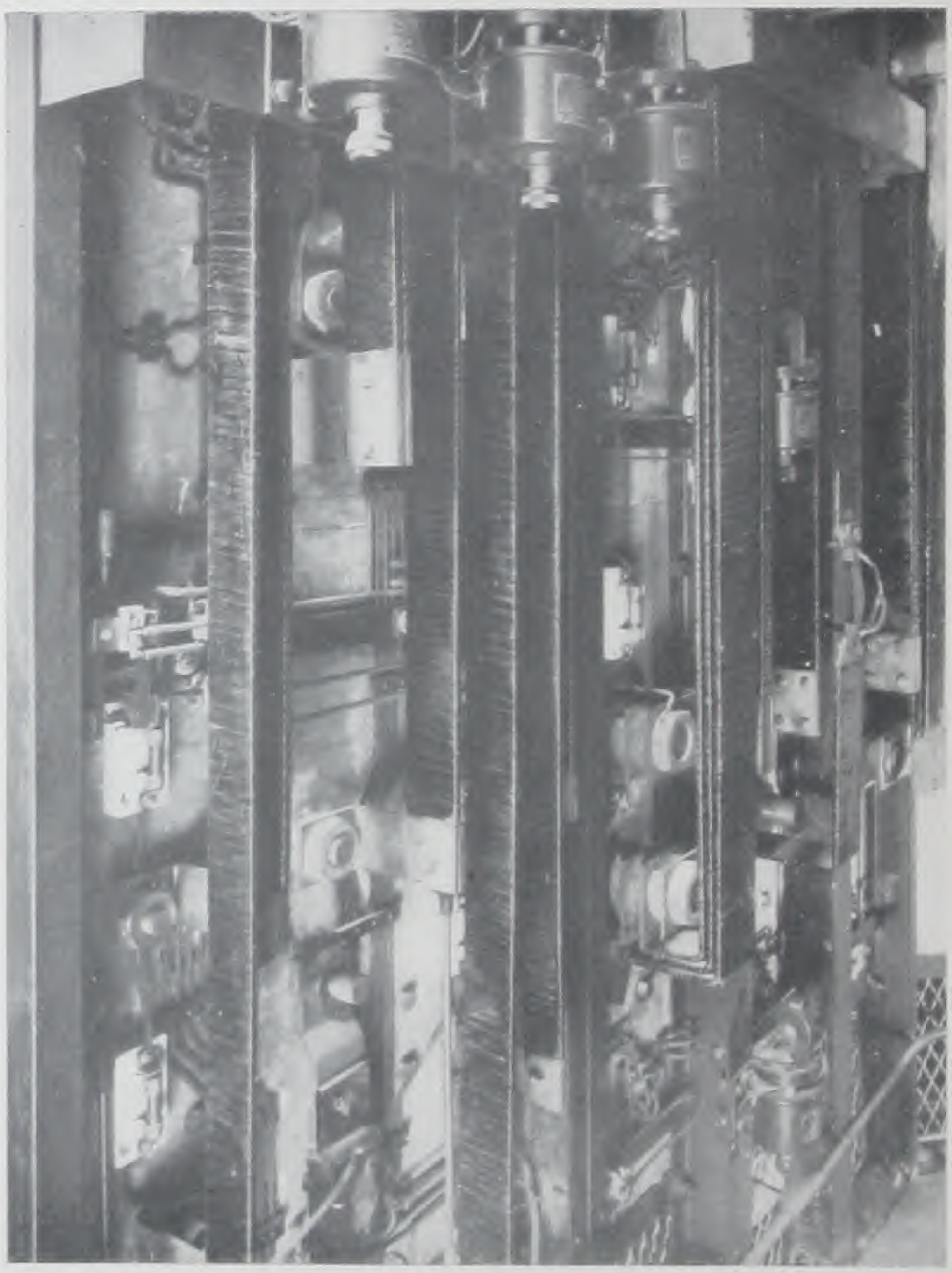


FIG. 21.—Details of Main Contactor Board, Switchboard No. 1.

first operated by the control switch itself, the latter operated by auxiliary switches on the contactors.

The generator and balancer rheostats are mounted on the wall behind the board and are driven from the rheostat wheels by the usual chain sprocket and shaft mechanism. There is a single rheostat for each balancer set arranged with a throw-over field switch so that the rheostat may be connected into the shunt-field circuit of either machine

in the set at will. This arrangement obviates the confusion usually attendant on the use of two independent rheostats.

OPERATING DESK.

The balancers are started by pump ratchet switches, which are short-circuited by the balancer contactors when these are closed after the machines have been run up to speed. The operating desk in the center

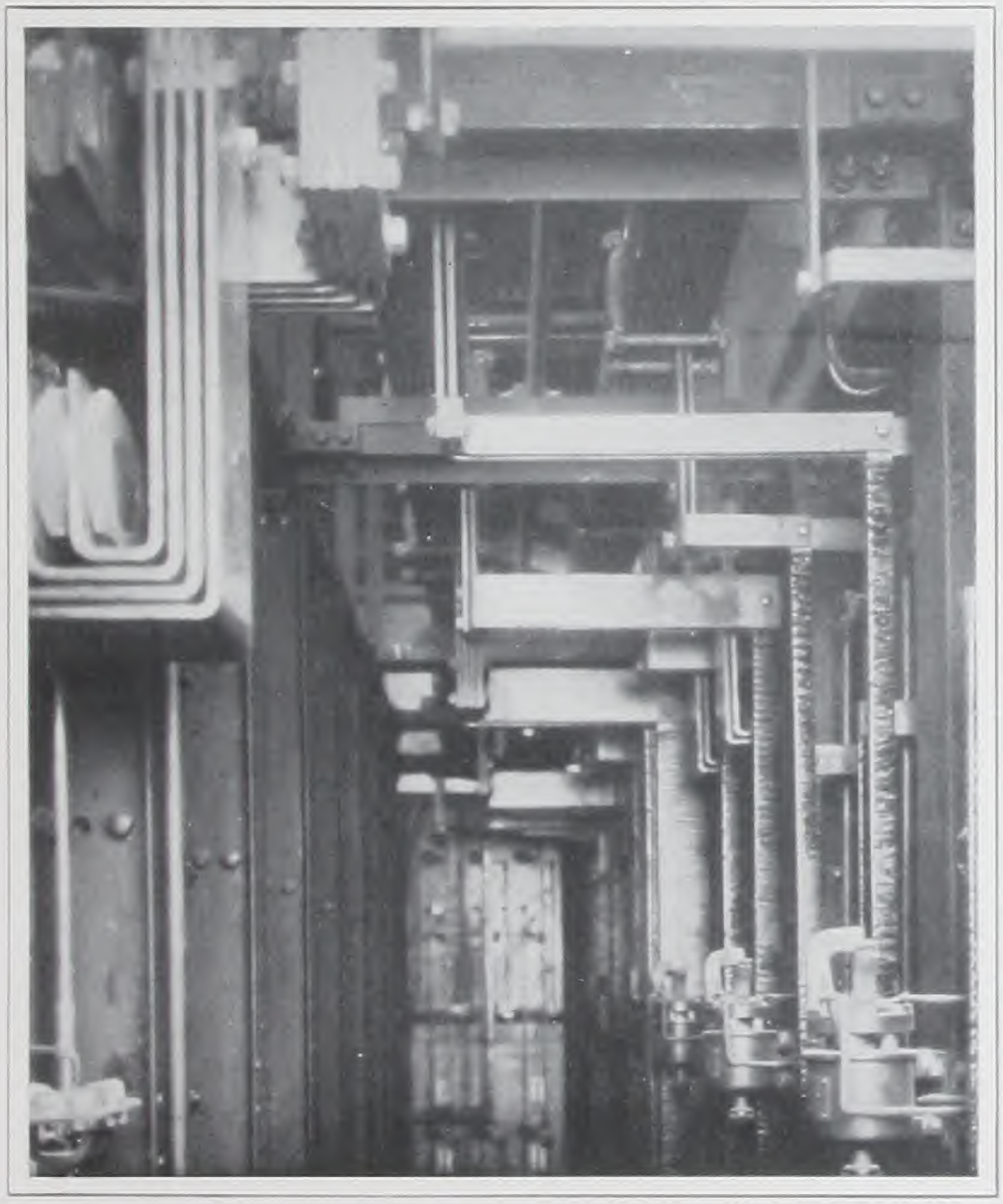


FIG. 22.—Details of Main Contactor Board, Switchboard No. 1.

of the benchboard is provided with log drawers, a plate-glass writing pad under which is a complete colored diagram of the connections, the voltmeter switches above mentioned, a portable lamp plug and receptacle, an exterior telephone set and an interior telephone set for calling and talking to the operators in the new engine-room. This set is self-contained and is directly connected to the set in the engine-room so as to be independent of the general battery service and thus to reduce failure to a minimum. For this purpose it is magneto-ringing and has

no talking battery, the energy for talking being generated by the voice with the aid of a repeating coil.

GONG SIGNALS.

A system of gong signals between the various parts of "Switchboard No. 1" has been provided. A push-button is located on the desk to operate a signal gong in the new engine-room. Each generator panel is also provided with a similar push-button operating a gong behind the control board so that signals can be interchanged using a code system. The control board gong is also operated through a relay by auxiliary switches on each contactor on the generator panels and on the contactor board. This relay is arranged to operate the gong continuously until reset by the operator. By this device attention is drawn to the board whenever a contactor opens, and the signal lamps indicate which circuit is affected.

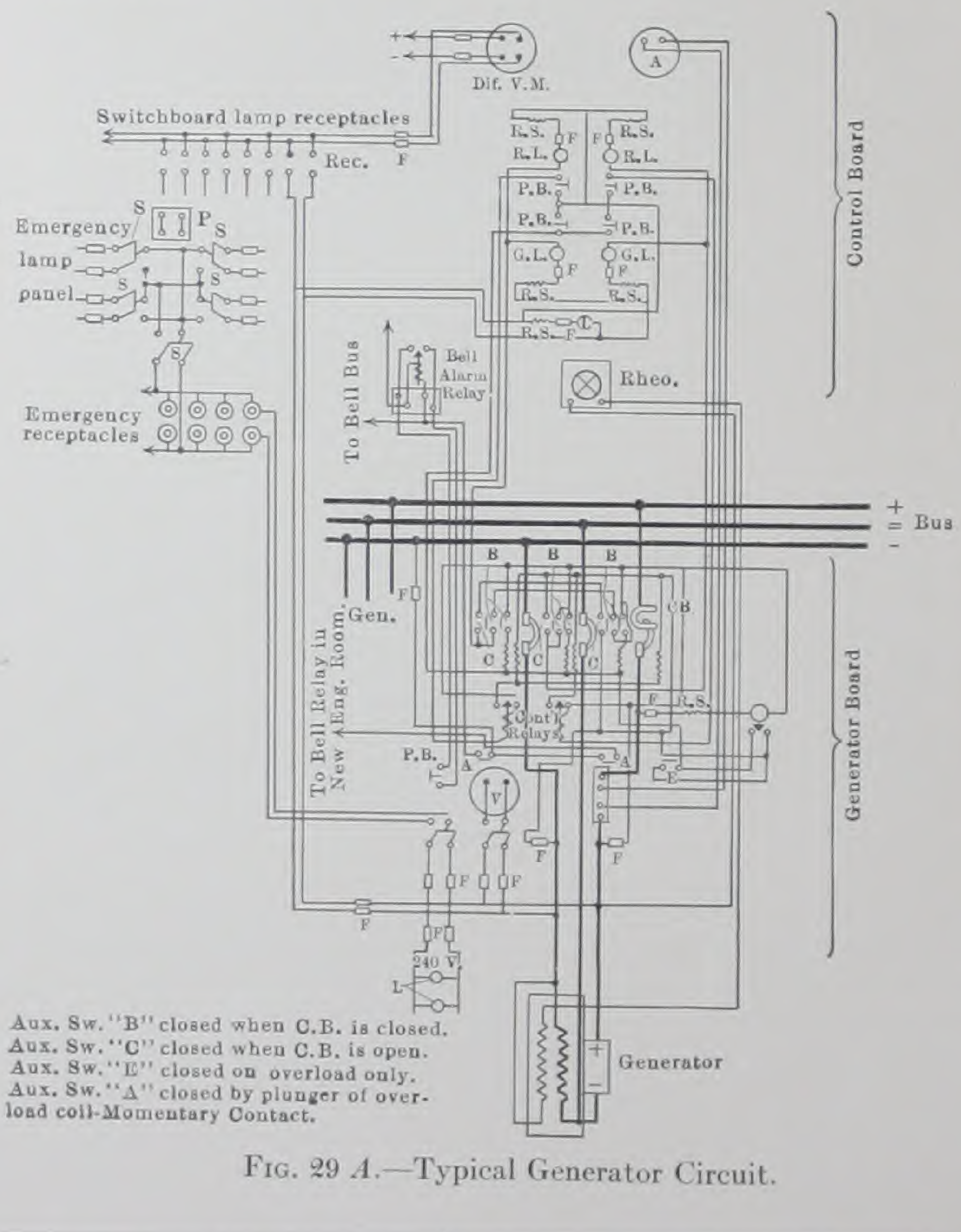


FIG. 29 *A*.—Typical Generator Circuit.

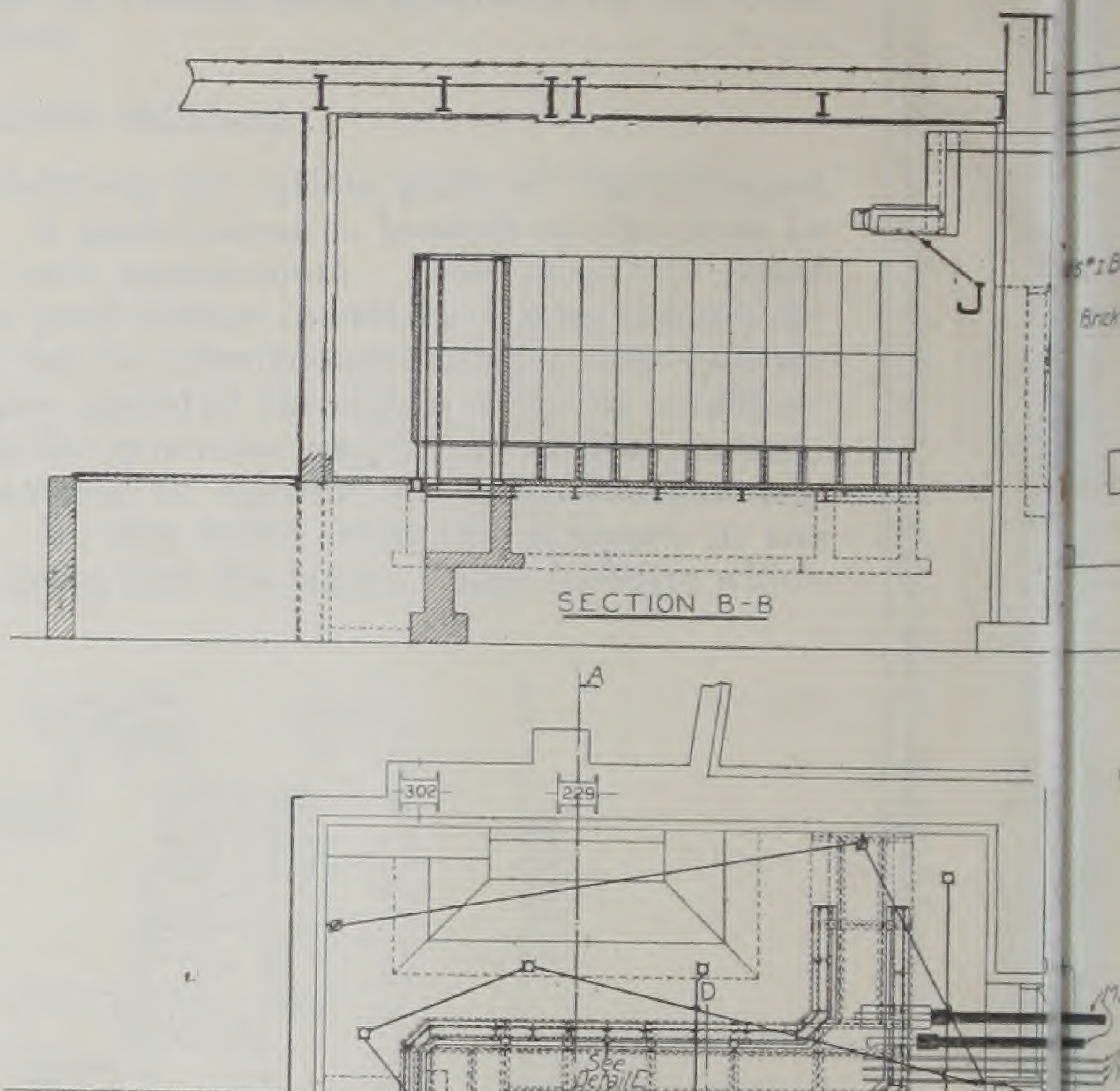
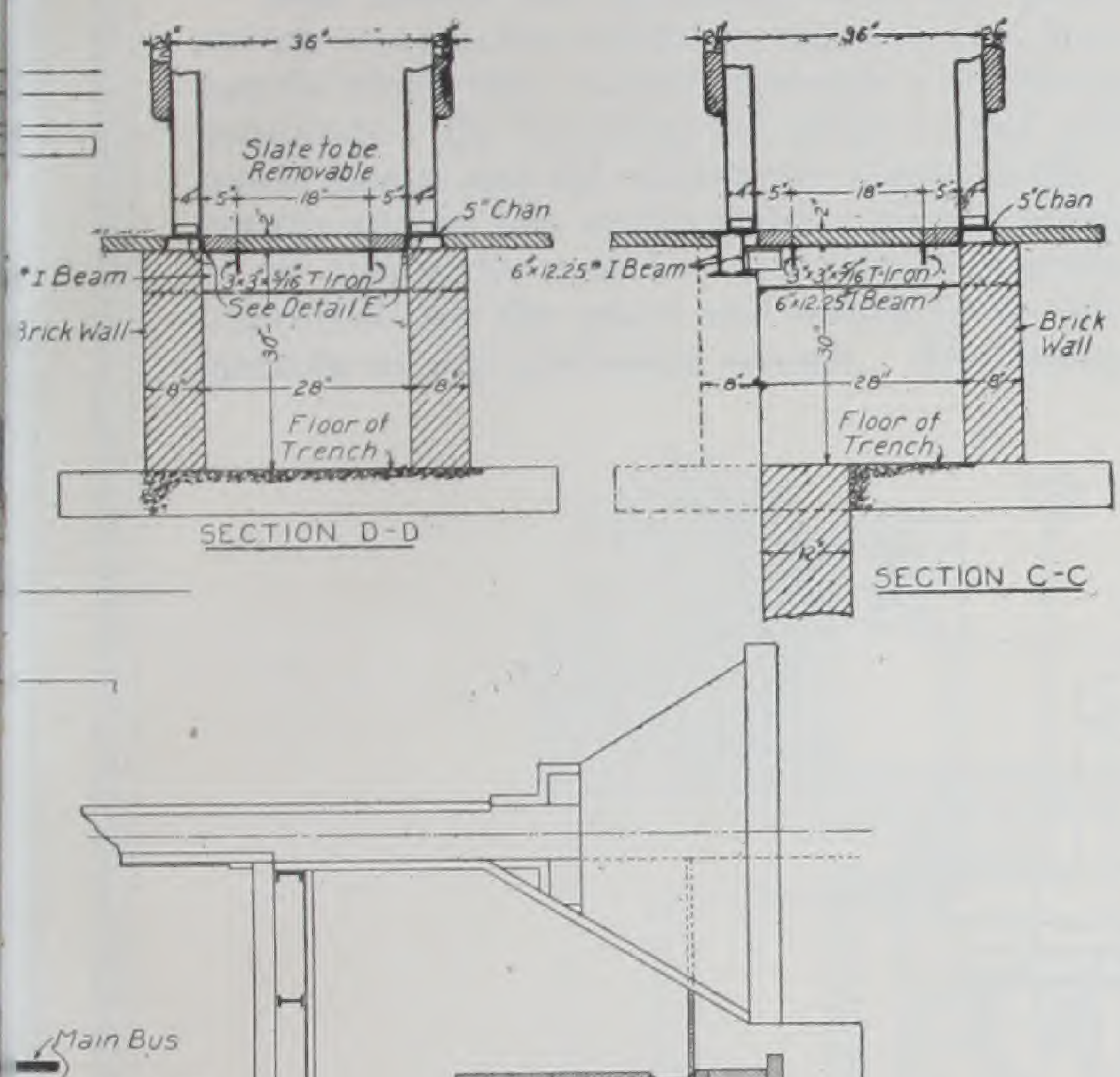


FIG. 27.—Detai Conta



ontactor Board.

Just above the operating desk are provided seven pairs of plug switch receptacles which are connected to lines running to the generator panels where they connect through a double-pole switch to the machine terminals. By inserting the plugs in any pair of terminals all switchboard lamps and the emergency lamps in the cellars, at the sub-switchboards and in the engine-rooms are connected to one generator back of all automatic switches and circuit-breakers. Thus it is practically impossible for the plant and cellars to be left in darkness through the opening of any generator circuit. The emergency lamps are mounted

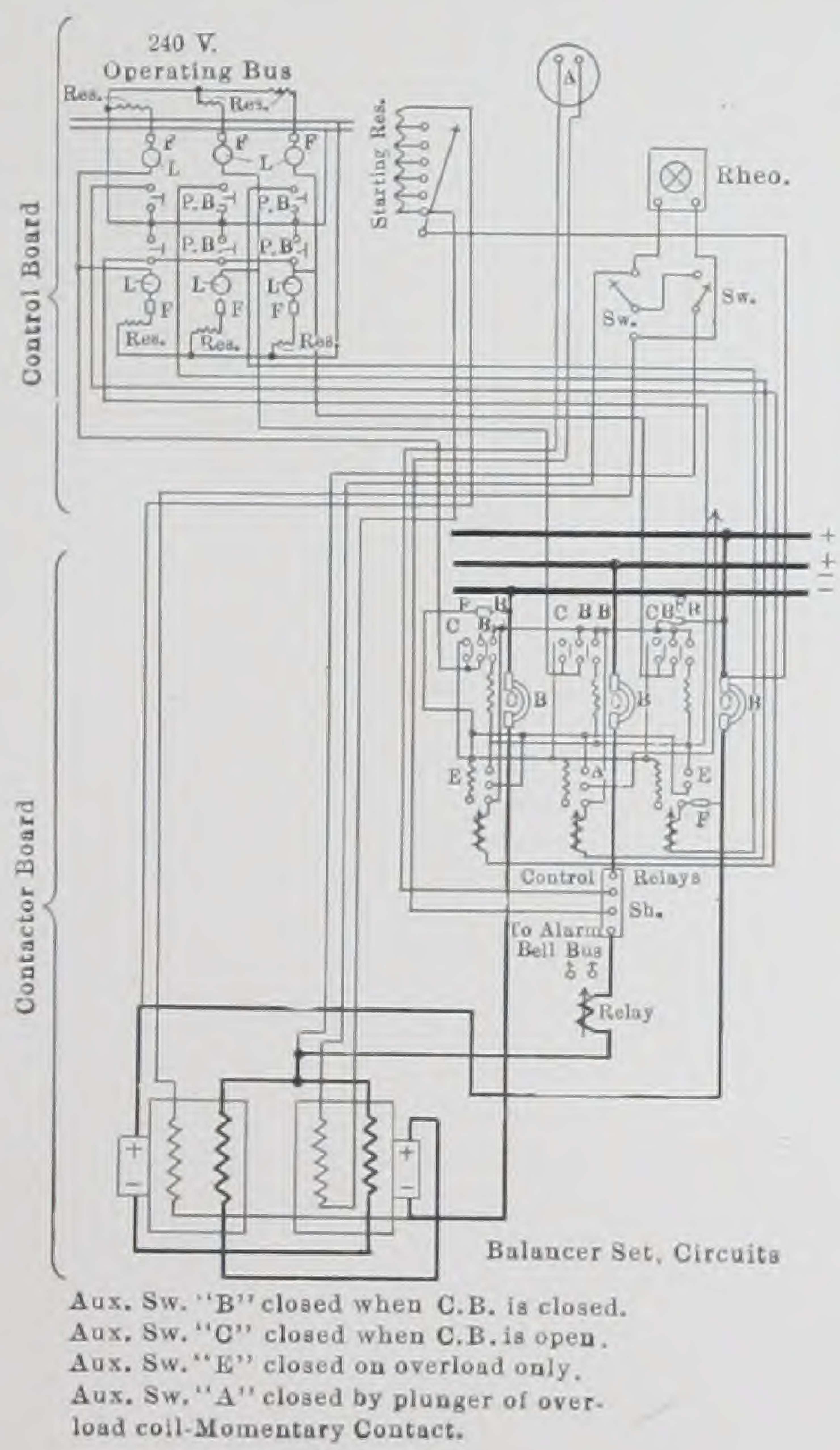


Fig. 29 *B*.—Balancer Set Circuit.

in lock sockets and operated at 240 volts. The "on" control switches of each generator panel are also connected to these lines so that it is impossible to close any generator contactor unless the machine is up to voltage and the double-pole switch on that generator panel has been thrown in.

It was first proposed to locate the control board temporarily in the old engine-room so that the old board could be left intact until no longer needed. Difficulties as to weights and the obtaining of temporary supports in the crowded cellar below made it necessary to erect the board in its final location. To do this a temporary wooden board and gallery was built over the generator panels of the old board, as shown in Fig. 19, and the feeders were successfully transferred to this temporary board with the plant in operation and without interruption of service. The abandoned feeder panels were then removed and the control board was erected in their place.

The control board is 15 ft. long and forms the principal feature of the engine-room, it being of remarkably handsome appearance.

MAIN CONTACTOR BOARD.

The main contactor board is located in a special room, as shown in Fig. 12. The board is in two parts back to back, and stands on retaining walls which provide a trench under the alley between the two

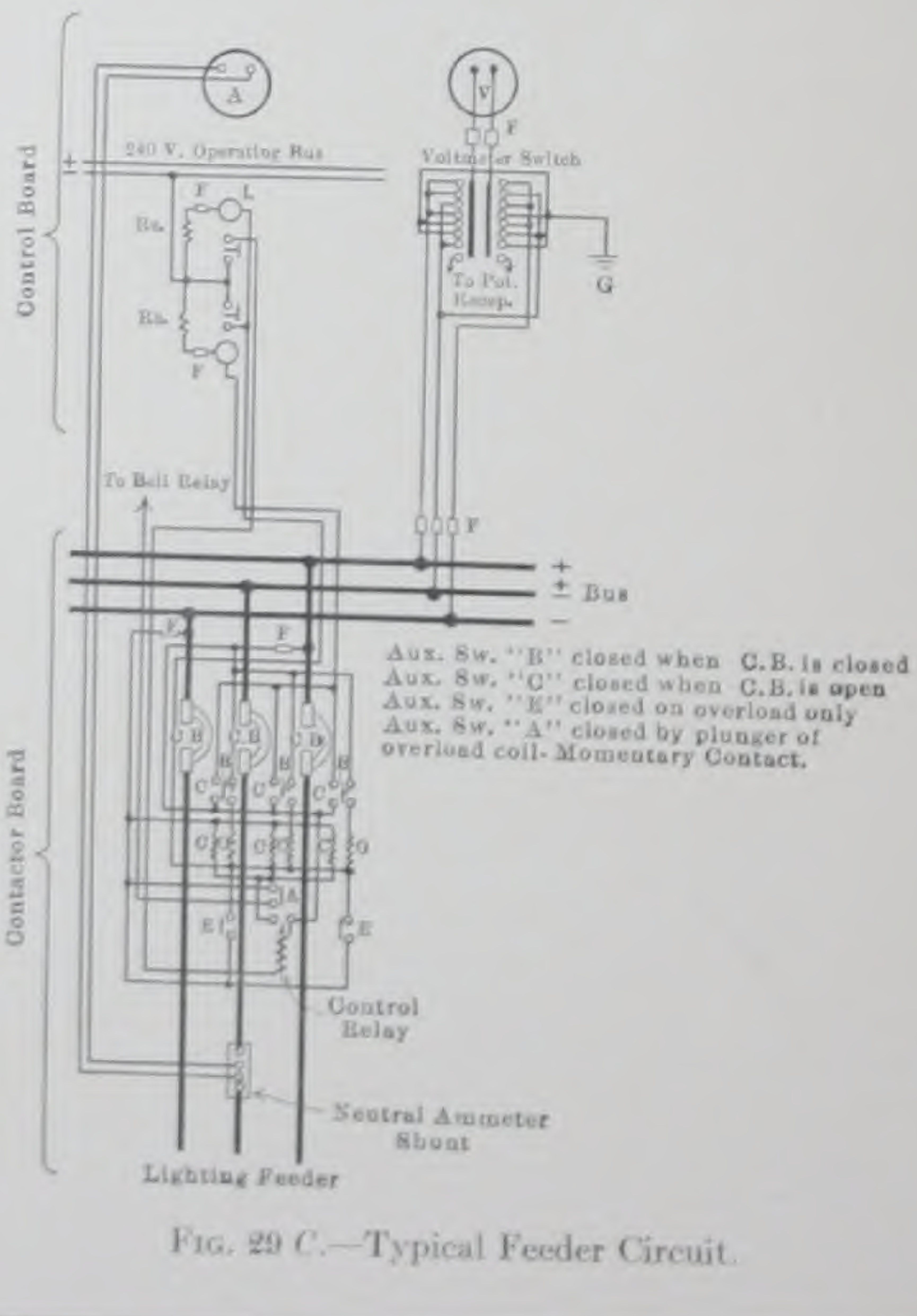


FIG. 29 C.—Typical Feeder Circuit.

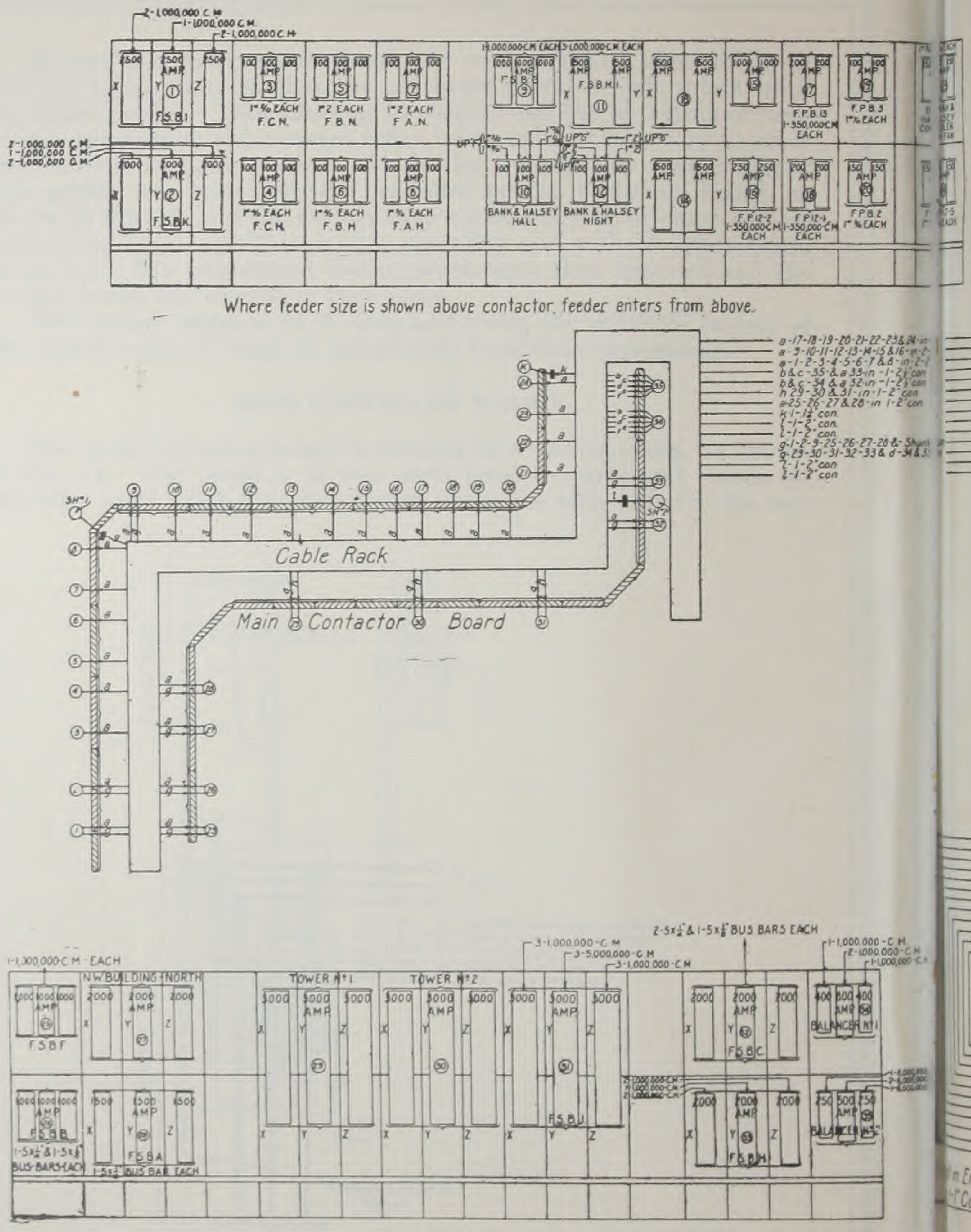
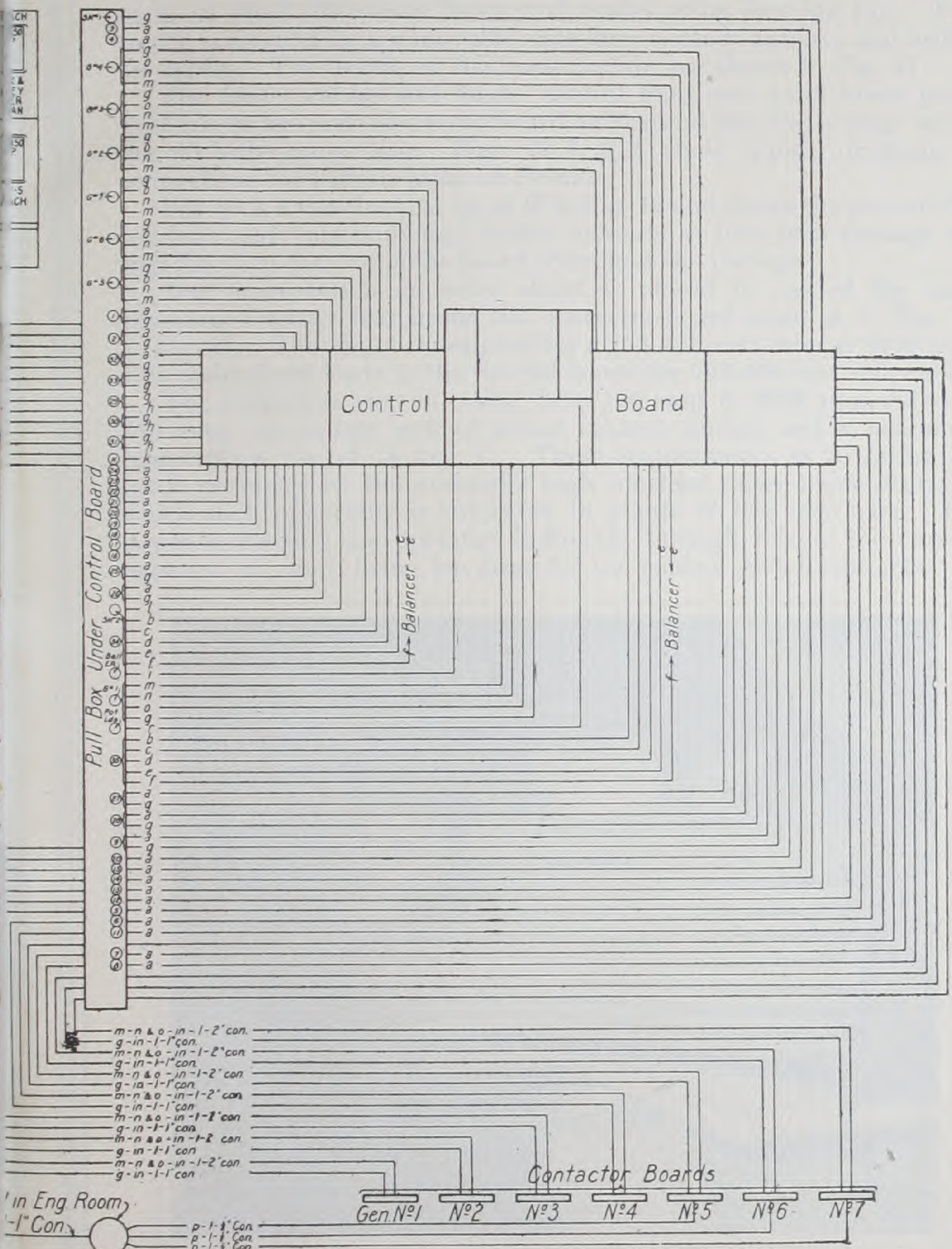


FIG. 28.—Working D



Switchboard No. 1.

parts in which the feeder buses and cables going east are run. This trench is covered by a removable slate floor slotted for buses and drilled for cables. The details of this construction are shown in Fig. 27.

The feeder cables and buses, control lines and main buses going west rise to the rack above the board and extend into the passage under the old boiler-room floor. Figs. 29 *A*, *B*, *C* show typical diagrams of connections for various kinds of circuits.

Fig. 30 is a view looking up at *H* in Fig. 12 and shows the control-line conduits and "old-building" feeder conduits as they pass through the wall between the contactor-board room and the passage.

The main-station ammeter shunt is placed in one of the main generator busbars just inside the contactor-board room at *I*, Fig. 12, *J*, Fig. 27. This shunt is designed for a 250-millivolt drop at 8000 amp. The main shunt leads to the control board are 750,000-circ. mil. cables.

The contactors vary in rating from 100 amp to 3000 amp, rated at 250 amp. per square inch of actual contact surface and a maximum temperature rise of 18 deg. C. These requirements as to rating are made necessary by the unusually high constant room temperatures to which such apparatus is subjected in plants of this character. The larger contactors are operated indirectly through relays, the current required (25 amp) being too large for the control switch contacts.

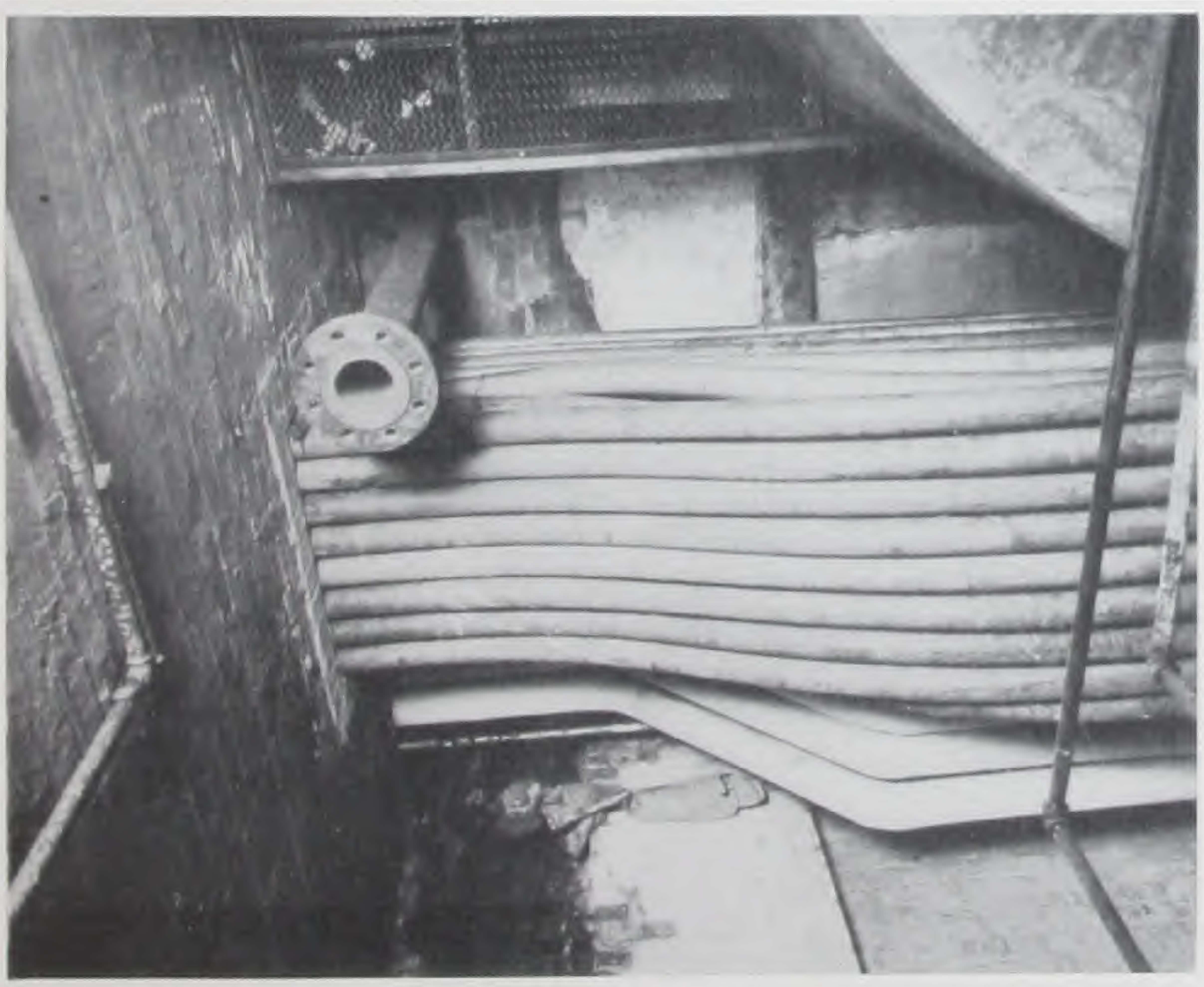


Fig. 30.—Conduit Detail (Looking Up).

The main busbars are run overhead, the connections to contactors being taken down as indicated in Figs. 21 and 22, which also show the contactor relays mounted in banks on the board frame.

The construction of this board, which, with all other switchboards in this installation, was built for L. K. Comstock & Co., by the General Electric Company, is a remarkable piece of switchboard engineering. The cramped space conditions and the peculiar shape of the room available made it necessary to economize every fraction of an inch in dimensions, at the same time allowing ample margin for growth and increasing loads.

MAIN DISTRIBUTING SYSTEM FOR LIGHTING AND MOTOR SERVICE.

The main distribution for lamps consists generally of three-wire main feeders controlled by three-pole, solenoid-operated, circuit-breakers or contactors on the contactor board. These main feeders terminate at sub-switchboards at the foot of the several riser shafts from which the rising feeders deliver energy to the centers of distribution on the several floors.

The distribution for motors consists of two-wire feeders run directly from the contactor board where service is intermittent or where direct control at the switchboard is required. For small motors and for portable devices the feeders are run from the sub-switchboards and are fed by the main lighting feeders. The only sub-switchboard for motor service alone is in the Northwest Building printing department.

The main lighting feeders in the additions to the North Building are in the form of busbars hung from the cellar ceiling and protected with wire-mesh grilles. Other feeders for lamps and motors to the old buildings are in the form of cables pulled in conduit.

The general arrangement of the horizontal feeder runs in the cellar of the new building is shown in Fig. 9. The general arrangement of the feeder runs to the old buildings is shown in Fig. 31, which also shows the tunnels under Bank Street (see Fig. 3), and the subway before mentioned in the cellars of the old buildings. The difficulties overcome in the arrangement and installation of this distributing system to the sub-switchboards were very great. In the first place the cellars of the new buildings were designed for only 4.5 ft. head-room, which was entirely occupied by steam and water pipes and ducts. In the short time available for study before it was necessary to begin the actual work of construction the unsatisfactory and almost impractical route indicated in Fig. 5 *A* was laid out, as it appeared to be the only route available. As soon as the contracts were awarded, however, detail studies were begun with a view to bettering these conditions. A great amount of energy and thought was expended in examining various possible routes and in making detail drawings of such routes in the attempt to fit the quantity of material required into the space obtainable. Finally the level of the cellar floors was dropped an additional

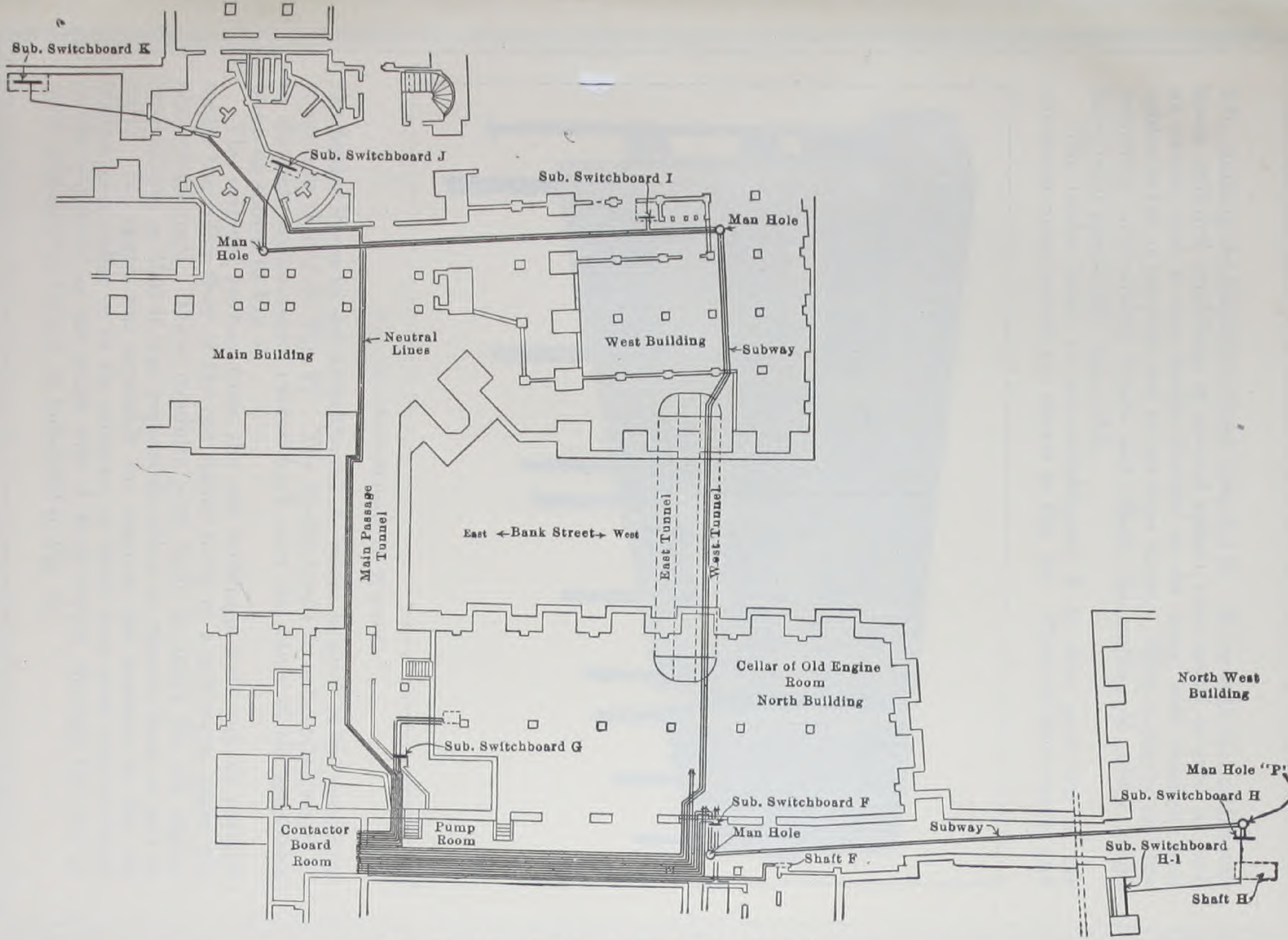


FIG. 31.—Layout of Feeder System to Old Buildings.

4 ft., making the maximum head room 8.5 ft. Even with this additional space crowded conditions at several points were found to exist to such an extent that it was finally decided to do away with conduits and cables as far as possible and to use bare buses. With conduits and the numerous unavoidable bends and offsets the pulling of cables would have been practically impossible.

The feeder buses to sub-switchboard *B* as they pass out of the contactor-room trench are shown in Fig. 34. Parts of these buses and

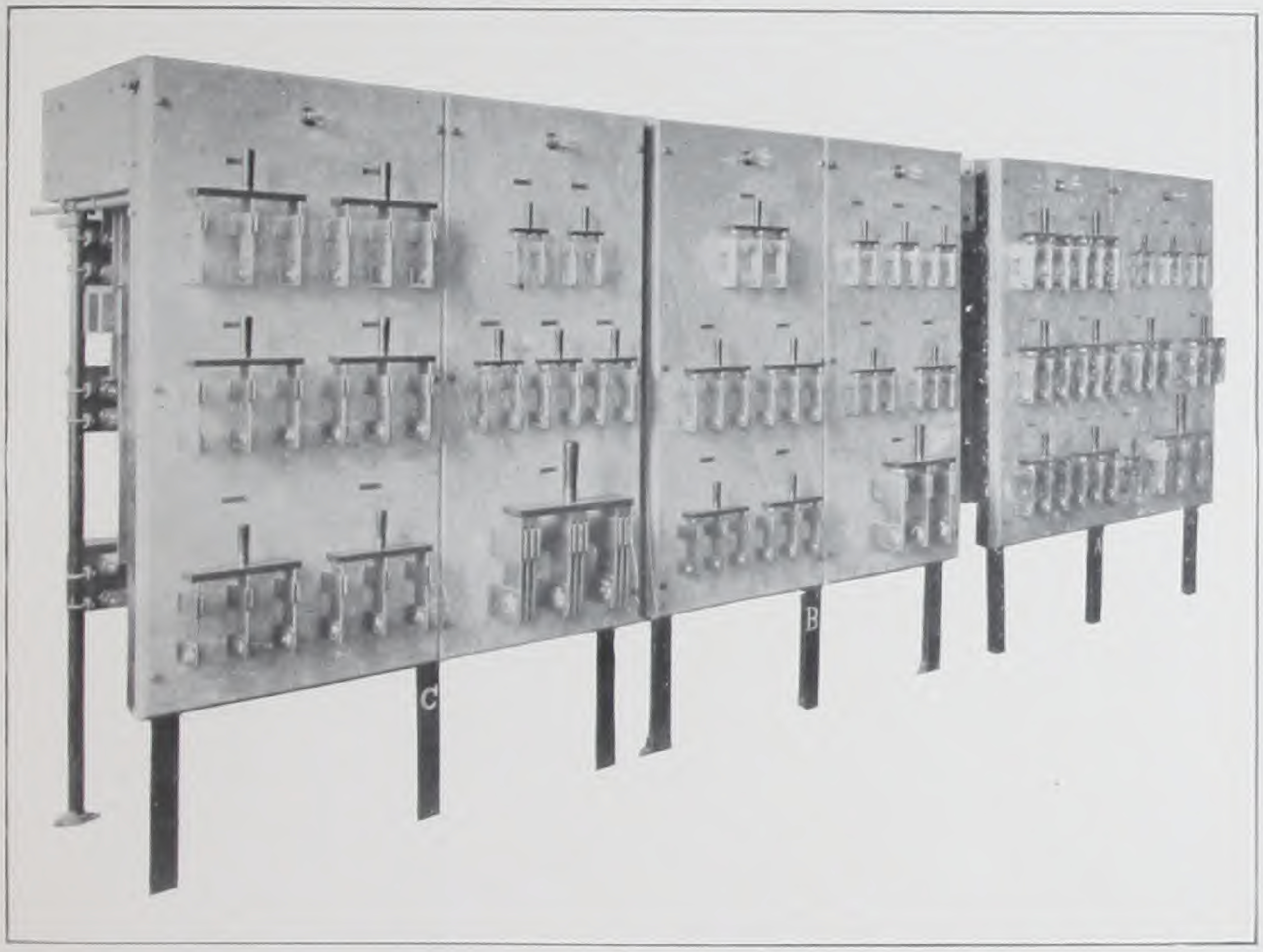


Fig. 32.—Switchboards *A*, *B* and *C*.

the feeder buses to sub-switchboard *A*, where located in the contactor room, are shown in Fig. 27. The feeder buses to sub-switchboard *C*, in the new engine-room, extend back over the route of the generator buses as shown in Fig. 9.

The original feeders from the old buildings were run in conduit under the cellar floor of the old engine-room to a pull-room under the old switchboard. These conduits were built in under the old engine foundations so that it was impossible either to remove them or add to them. No space was available for running the neutrals in the old engine-room cellar or in the subway, so these lines were run overhead to the buildings on the south side of Bank Street, through the east or main passageway tunnel, as indicated in Fig. 31.

The general character of the sub-switchboards is shown in Figs. 32 and 33, where the three sub-boards *A*, *B* and *C* are set up side by side. These boards have an unfused, main three-pole, knife switch and fused,

Fig. 33.—Switchboards *A*, *B* and *C*.

three-pole and two-pole feeder switches. The feeder fuses are open links of composition placed on slate fuse slabs supported at the rear of the board. Bus extensions from the fuse slabs terminate at lugs inside the slate pull boxes supported behind the upper part of the board. The riser conduits terminate in these pull-boxes, and the feeder cables are there distributed and connected to the proper lugs.

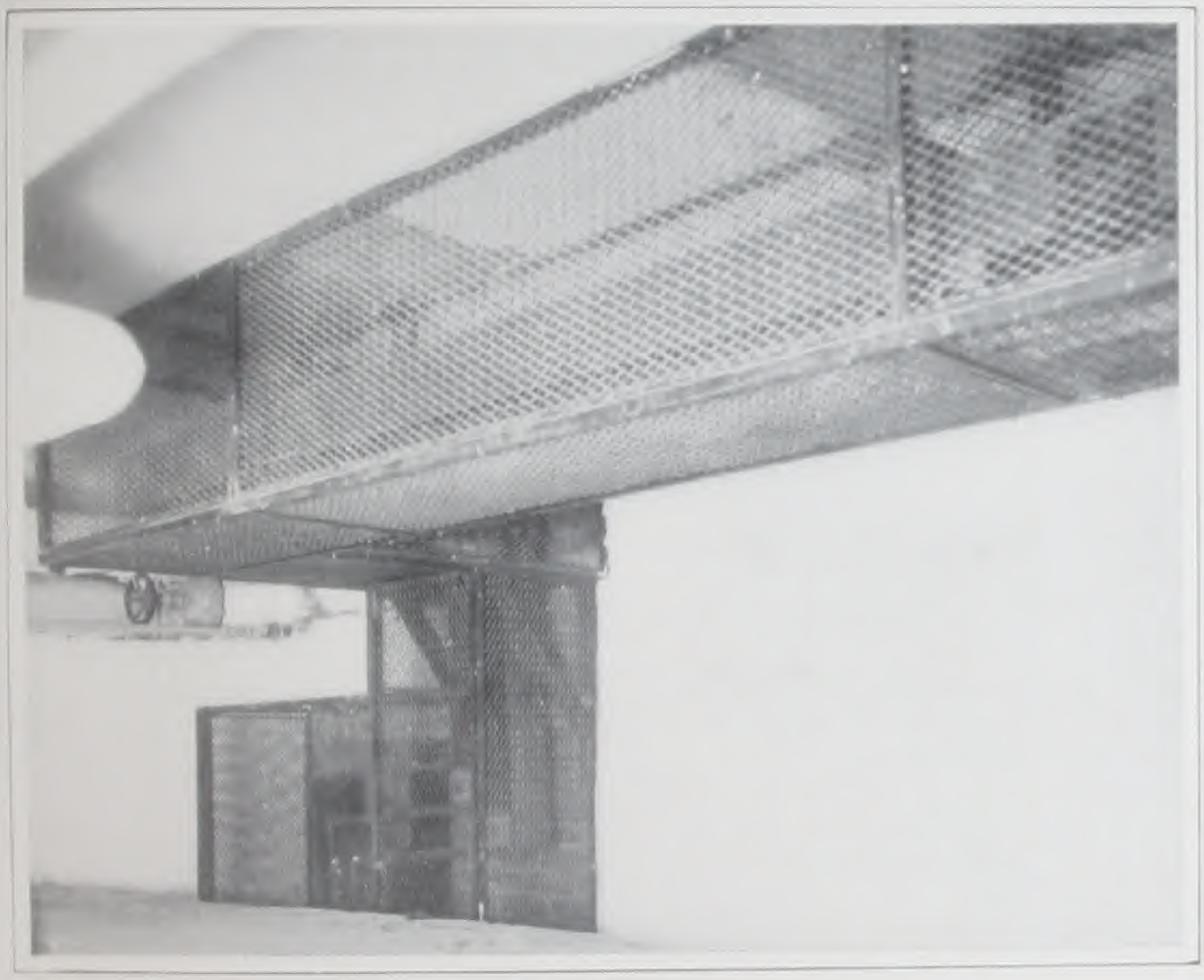


Fig. 34.—Feeder Busbars and Cage.

PIPE WORK.

Sub-switchboard *C* is shown set up without its inclosing grille in Fig. 35. The bus feeders may be seen rising through the marble floor from the busbar tunnel below. Sub-switchboard *F*, in the passageway under the old boiler-room floor, is shown in Fig. 36. These last two figures indicate the very crowded conditions existing in the old portion of the North Building, and show how in remodeling isolated plants of this character the best must often be made of undesirable locations. Just above and behind sub-switchboard *F* the mass of conduits shown in Fig. 30 pass through the wall separating the passage from the old engine-room cellar and enter the pull-room shown in Fig. 40. It is

unfortunate that a photograph could not be obtained of this extraordinary bit of pipe work.

The method of extending the old building feeders to the contactor board is shown in Fig. 40. The extensions were run to this pull-room

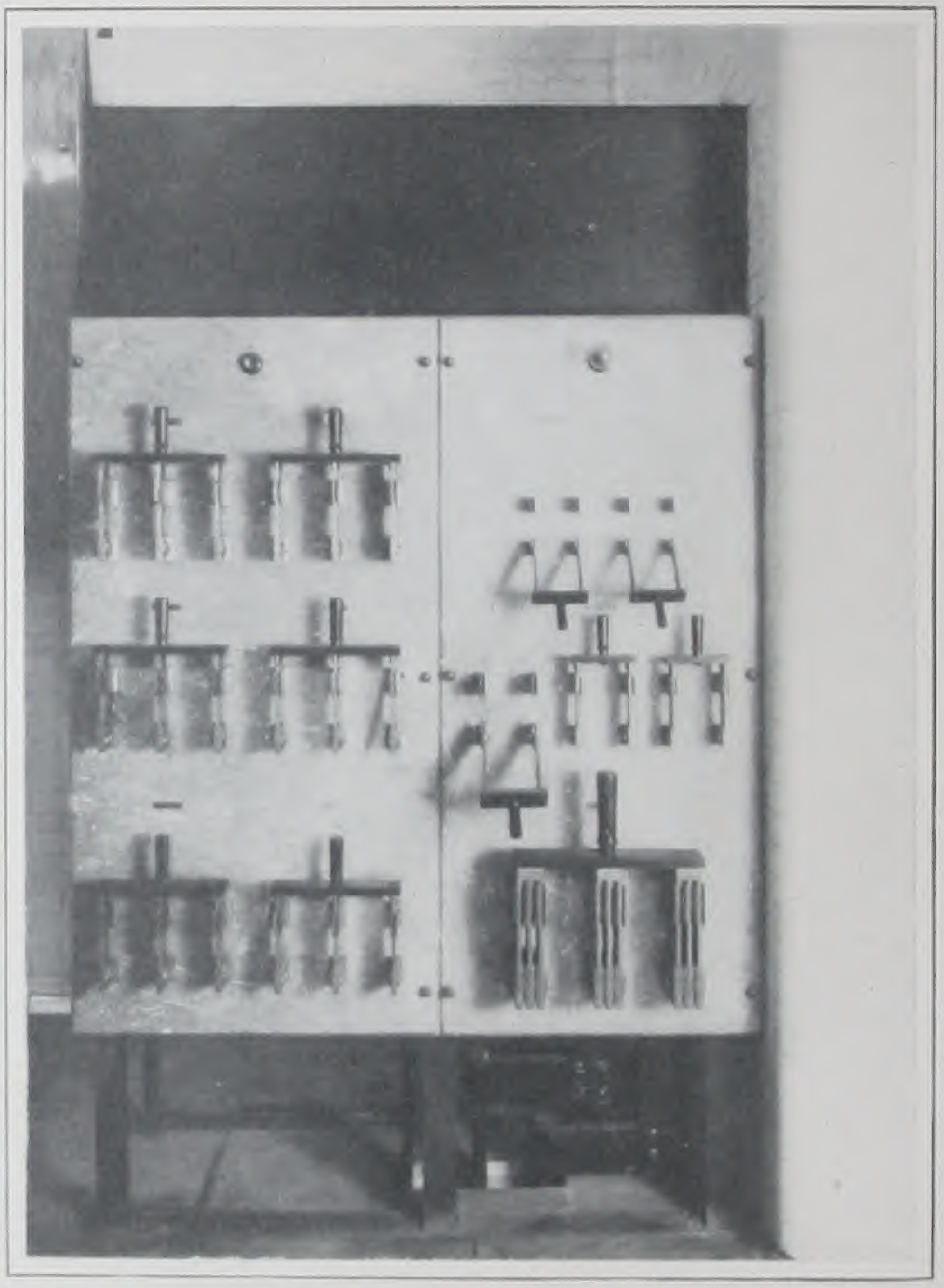


Fig. 35.—Sub-Switchboard *C*.

and spliced to the old feeders while alive just before the plant was to be turned over. As the circuits in each building were connected to the contactor board the feeders were cut loose from the old switchboard by the simple expedient of sawing them through, and the ends were insulated, taped and painted as shown. At the same time the three-wire to two-wire straps were taken off the sub-switchboard main switches and the neutral lugs were bolted in place.

Most of these photographs were taken before the cables were arranged, the pull-boxes installed or the work finished, so as to illustrate the mass of connections to be handled, all of which, including taking down the old two-wire boards, was done while the buildings were in operation and without interruption of service.

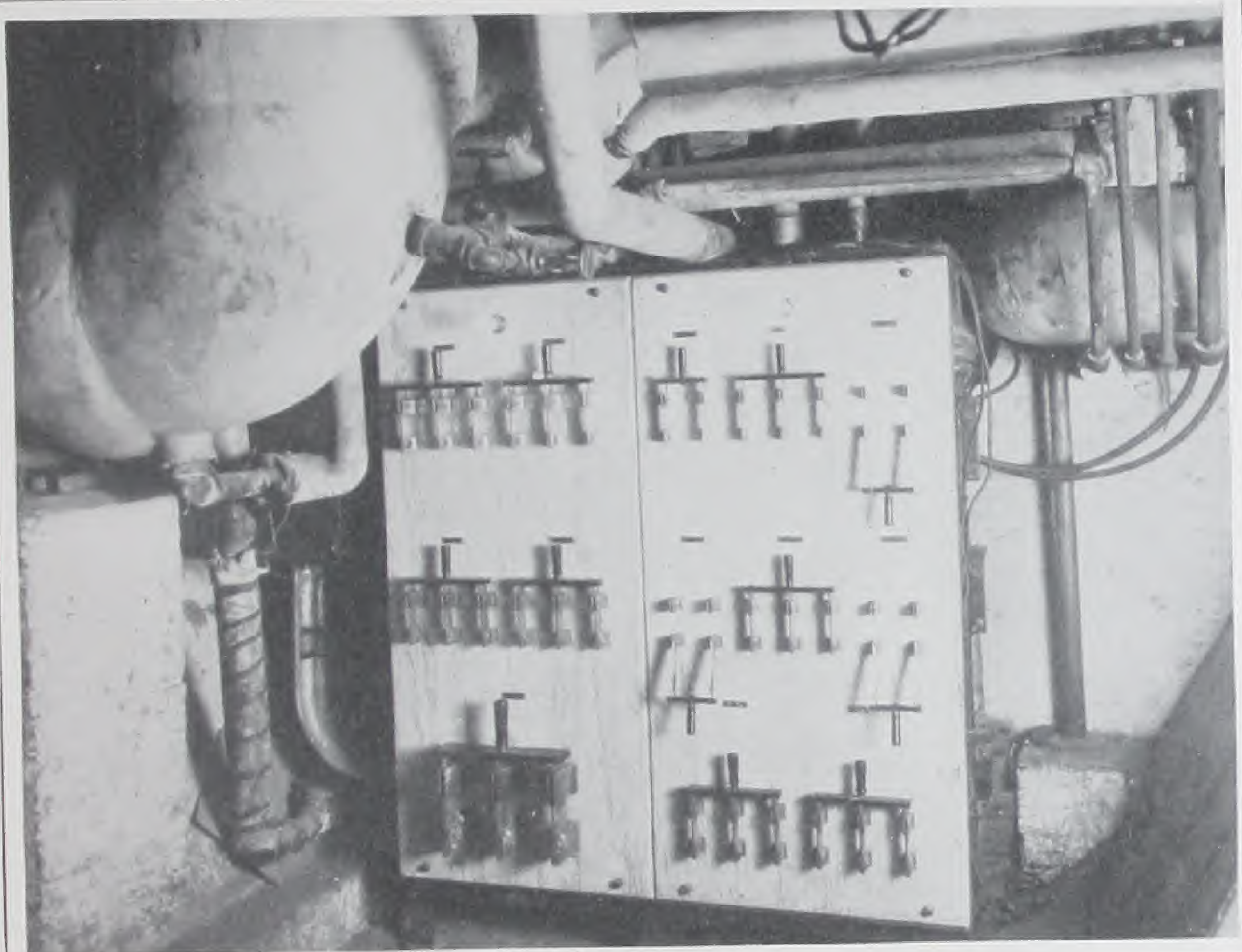


Fig. 36.—Sub-Switchboard *F*.

The distributing system in the additions to the North Building was complicated by the fact that the Public Service Corporation had leased the entire Bank and Broad Street corner portion and two entire floors of the Bank and Halsey Street portion and the Academy and Halsey Street portion. This company naturally furnishes its own energy for lamps and motors. For lighting service use is made of a 120–240-volt, single-phase, 60-cycle, three-wire system. For motor service 500 volts direct current is employed. Hence it was necessary to provide in different portions of the building three distributing systems for different services, and to arrange these systems so that should the Public Service Corporation move to other quarters the entire system might be connected to the Prudential plant at a minimum cost.

In order to bring energy for lamps and motors for the elevators to the two floors sandwiched in between the sections of the new building

occupied by the Prudential Insurance Company, it was necessary to bring both types of Public Service lines from the main Public Service switchboard through the Prudential cellars. These lines were run in a subway system built along the cellar floor following the routes indicated in Figs. 9 and 45. This subway system, which was also built to carry

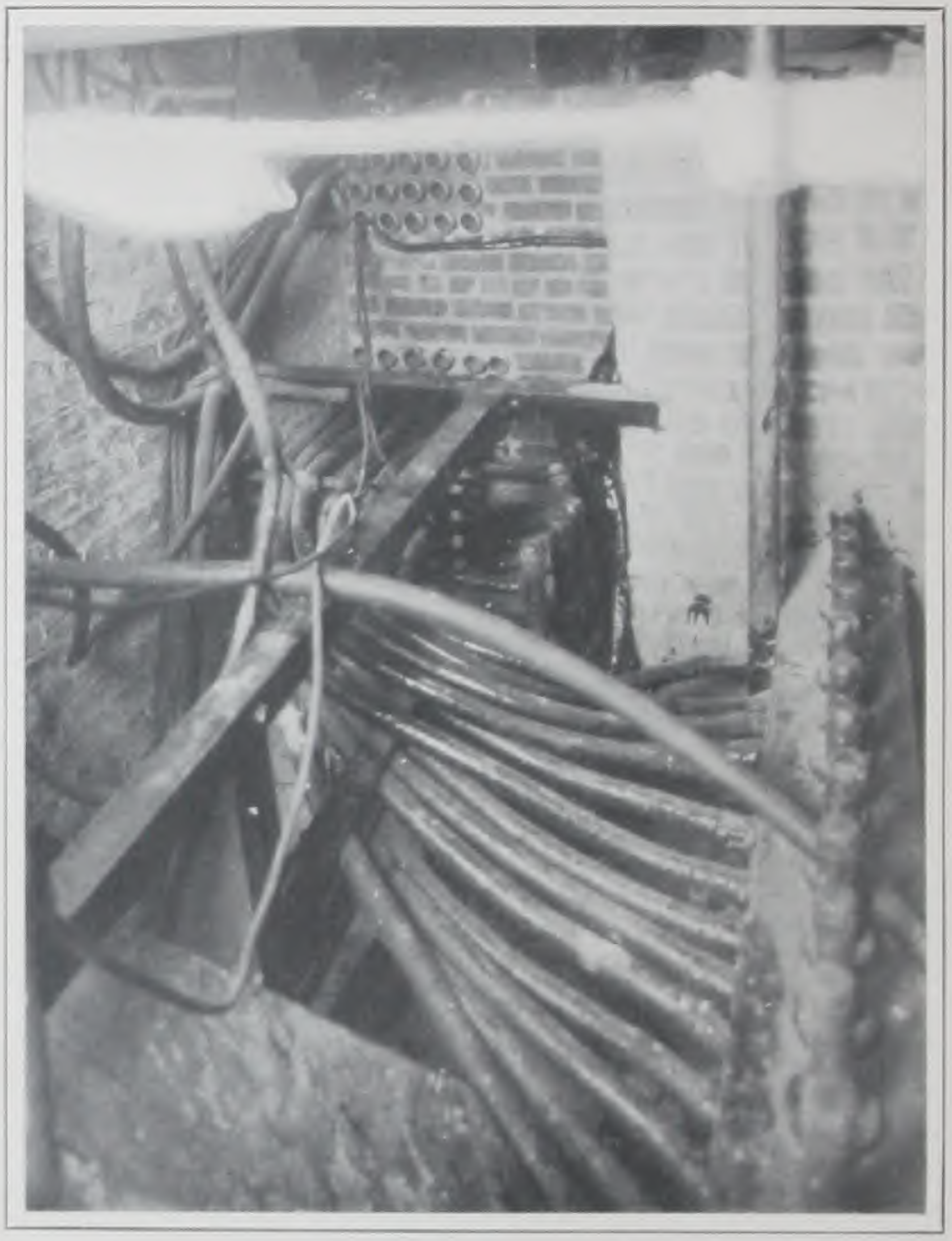


FIG. 40.—Pull-Room Under Control Board.

both Prudential and Public Service feeder cables for telephones and call bells, was constructed of Orangeburg fiber ducts embodied in concrete with brick manholes.

SUBWAY SYSTEM.

The construction of this subway in the cramped space available and over a surface continually interrupted by column grillages was no easy task. Detail studies were made of the entire cellar floor, and

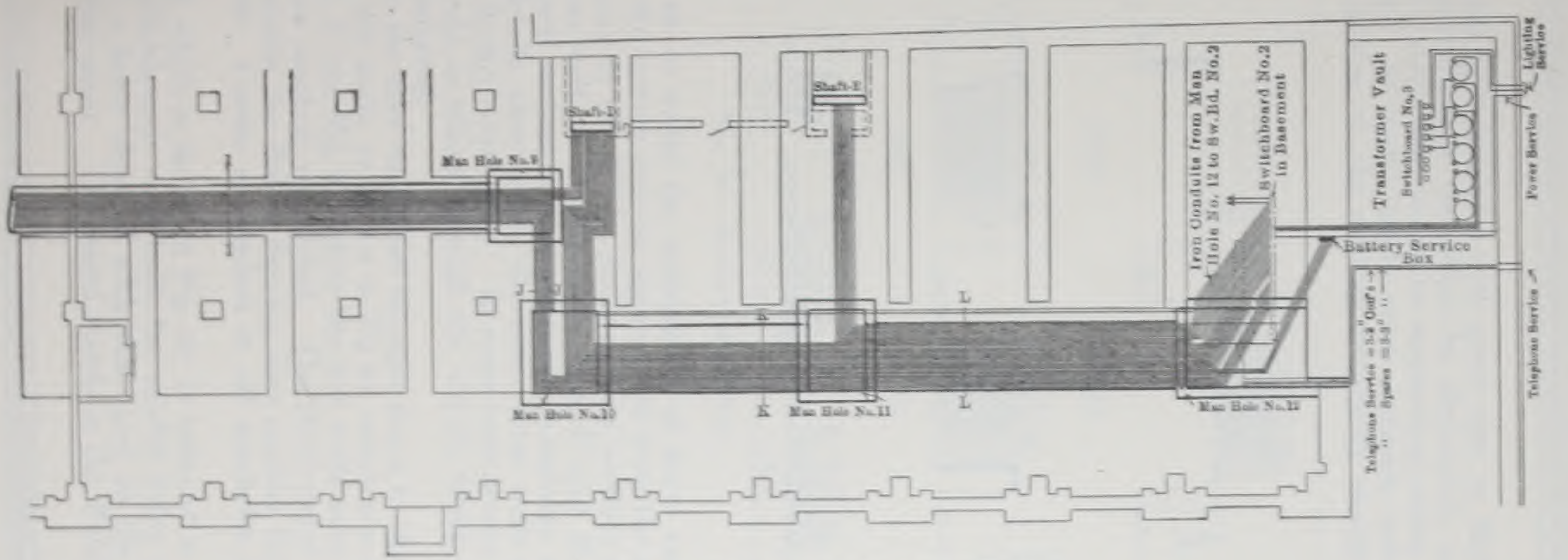


Fig. 45.—Subway System in Public Service Portion.

working drawings were prepared with great care so that at no point would free passage through the cellars be obstructed, and to prevent the selection of a route that would be impractical owing to unforeseen space conditions. At many points every available inch was utilized, and the cross-section of the subway frequently changes in form, as

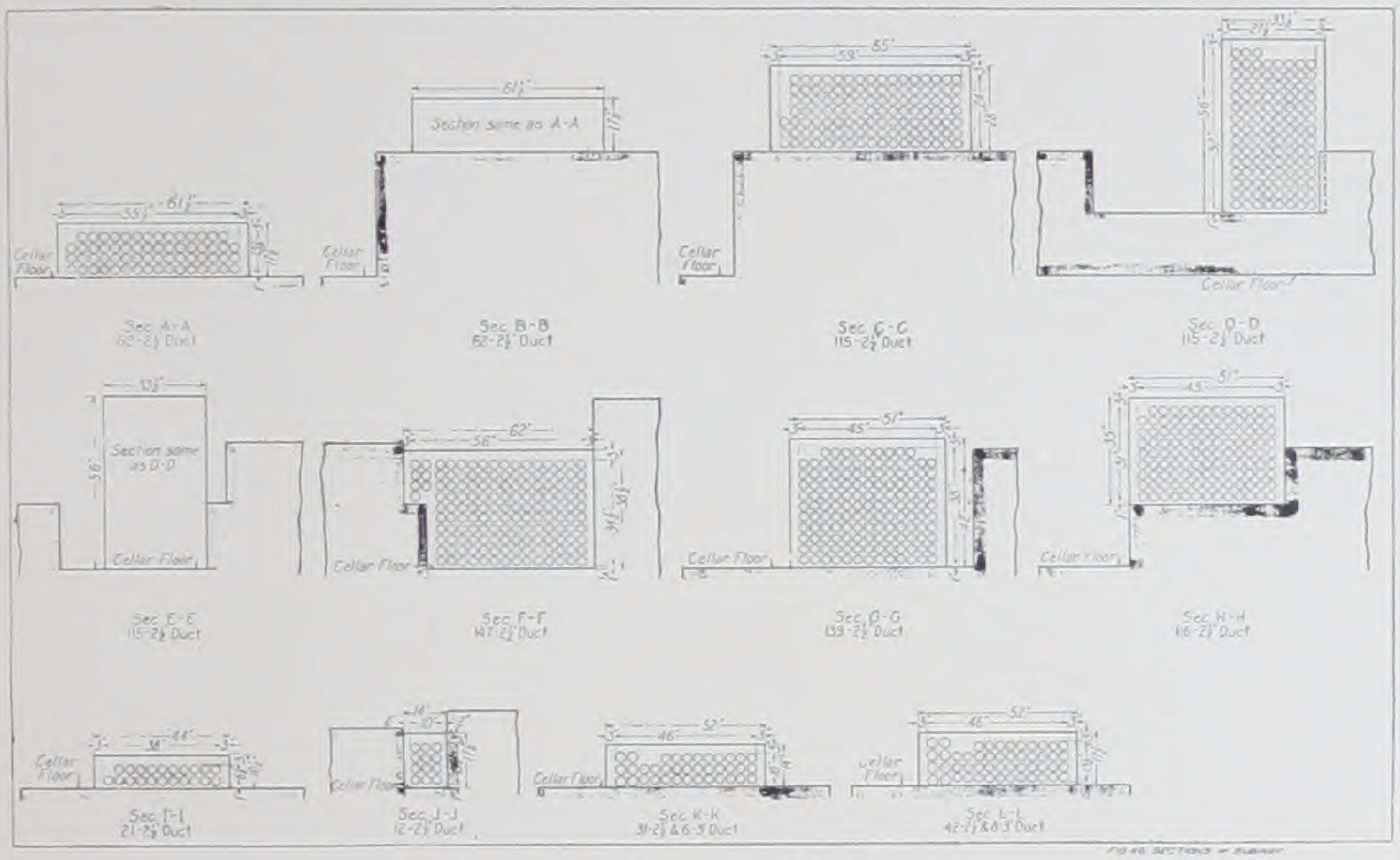


Fig. 46.—Section of Subway.

shown in Fig. 46, to avoid the multiplicity of ducts and pipes. The magnitude of the system may be appreciated from the statement that there are as many as 147 $2\frac{1}{2}$-in. ducts in some sections of the subway. The subway was built, as illustrated in Figs. 47 and 48, by setting up the ducts in each section with wooden-end templates made from the cross-section details, after which the outer form walls were built and the whole was flushed with grout. In some cases access to manholes is had from the side, in others through the covers, which in all cases are of flat steel reinforced.

Conduits to the riser chases are brought down to the manholes and built into the side walls, as shown in Fig 47, which is a view of the site of manhole No. 6 (see Fig. 9), before the side walls were built. Fig. 50 shows this same manhole completed. The sheet-metal box appearing in this cut contains the Public Service lines passing through this particular manhole. Cables are racked in all manholes in the manner indicated.

This board, which is shown in Fig. 51, is believed to be one of the handsomest switchboards ever built, the marble being white Vermont statuary, with a finish identical with that used on the control board in the Prudential plant. The board stands in the Public Service Cor-

poration's display-room and forms a part of the permanent electrical exposition maintained in this building. It is divided into two sections, one for the alternating-current lighting service fed by three 100-kw transformers located in a vault under the sidewalk, and a motor-service section controlling elevators, fans and other machinery.

VERTICAL CHASES.

There are five vertical riser chases in the new building, two in the Public Service portion and three in the Prudential portion. These chases were originally intended to be open chases with grille platforms

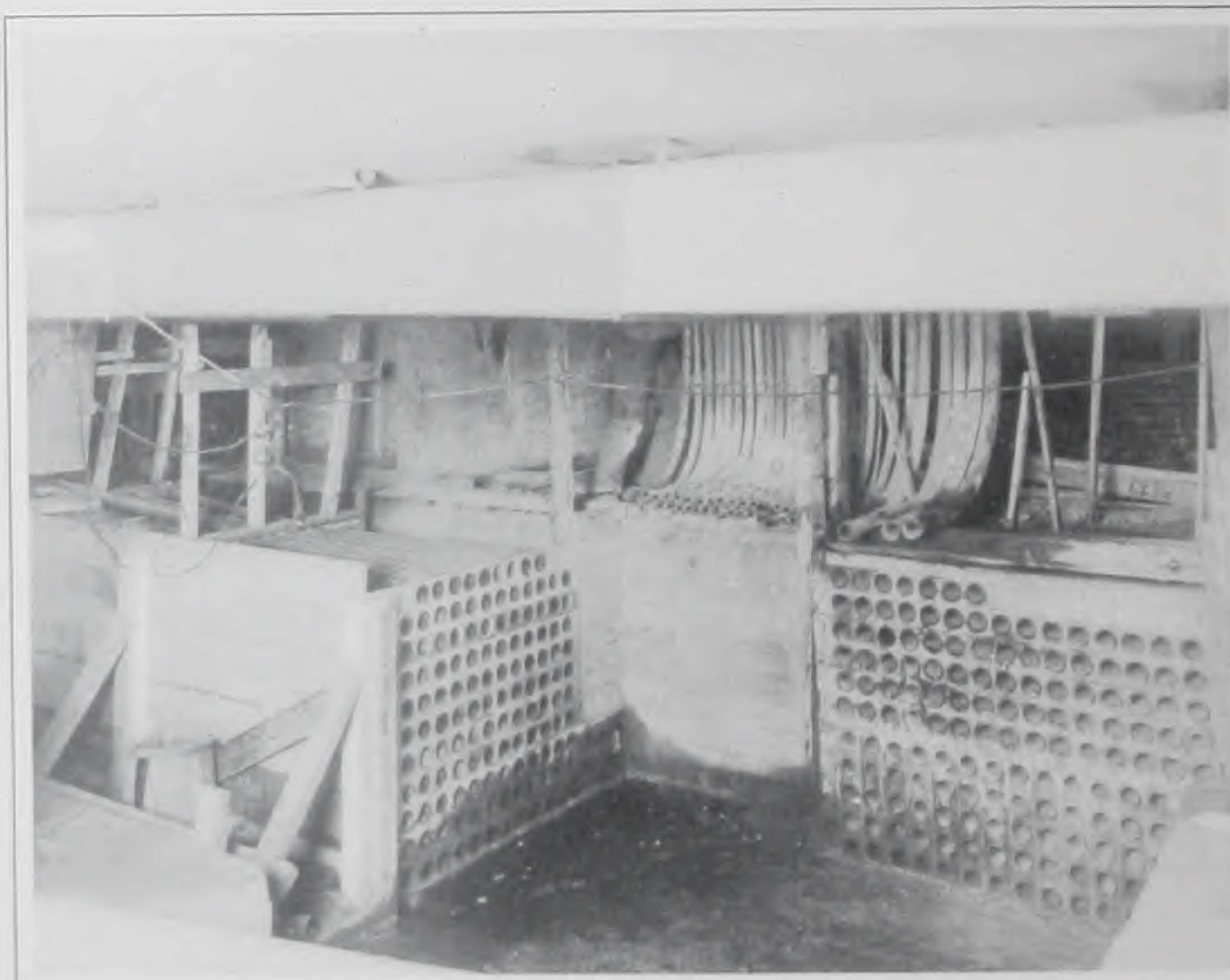


FIG. 47.—View of Manhole No. 6. Not Completed.

on each floor level, access to the shafts being obtained through doors on each floor. However, final space conditions did not permit such an ideal arrangement, and the grilles were not used, access to the shafts being obtained through manholes in the panelboards with the single exception of shaft C, where a door was used.

The general diagrammatic arrangement of the riser system is indicated in Figs. 53 and 54. The former shows the three shafts in the Prudential portion and also indicates the connections to the second

and third floors occupied by the Public Service Corporation. The latter shows the two shafts in the Public Service portion. The riser system is in each case divided into three sections, for general lighting, hall lighting and night lighting. The feeders for general lighting usually run to two or three floors, the feeders terminating at one panel, the other panels fed by this feeder being connected to the feeder terminal by loop mains of the same size as the feeder. This arrangement avoids the use of feeder fuses except at the sub-switchboards.

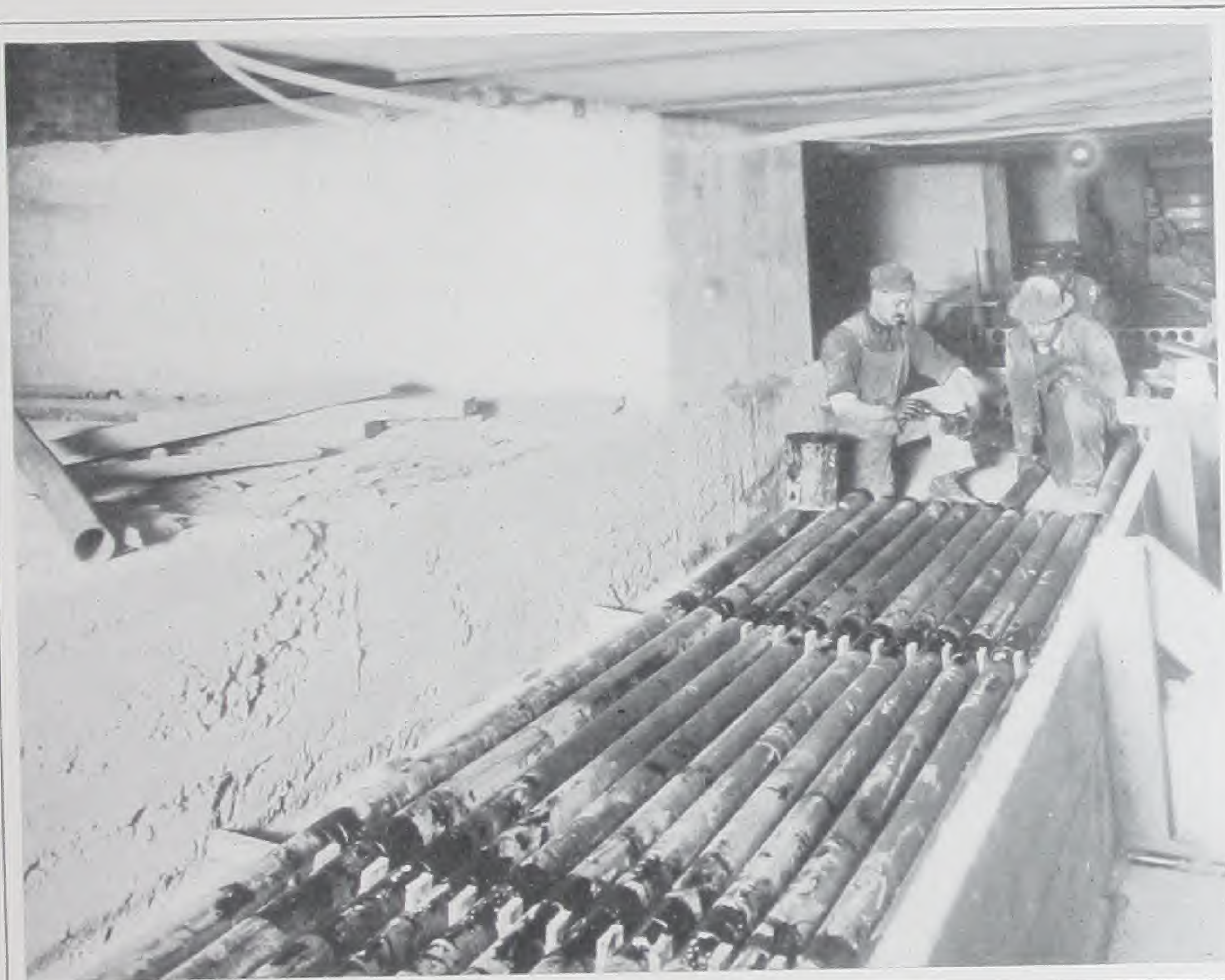


Fig. 48.—Detail of Subway Construction.

The hall and night feeders run to the lowest panel in the riser and loop through from panel to panel, one-size conductor being used throughout to avoid fuses in the panels. All hall and night lamps in each system are thus fed with energy from the main centers of distribution independently of all other lights and are controlled at the main switchboards.

Certain subsidiary risers for small portable motors are run from the sub-switchboards up several of the columns on the outer walls through small cut-out boxes on each floor so that connections may be made as desired to window fans, etc., without going back to the panelboards. Other independent motor-service risers are run from the sub-switch-

boards to motor panels and motors in several departments where such machines are used. Feeders to the elevator panels in the Public Service portion are run directly to the main service board. Independent feeders are run from sub-switchboards to panels in the elevator machinery rooms, to which are connected all lamps used in connection with the elevators.

The panelboards for lighting service are generally divided into three separately fed sections, for general lamps, hall lamps and night lamps, marked G, H and N respectively on the riser diagrams.

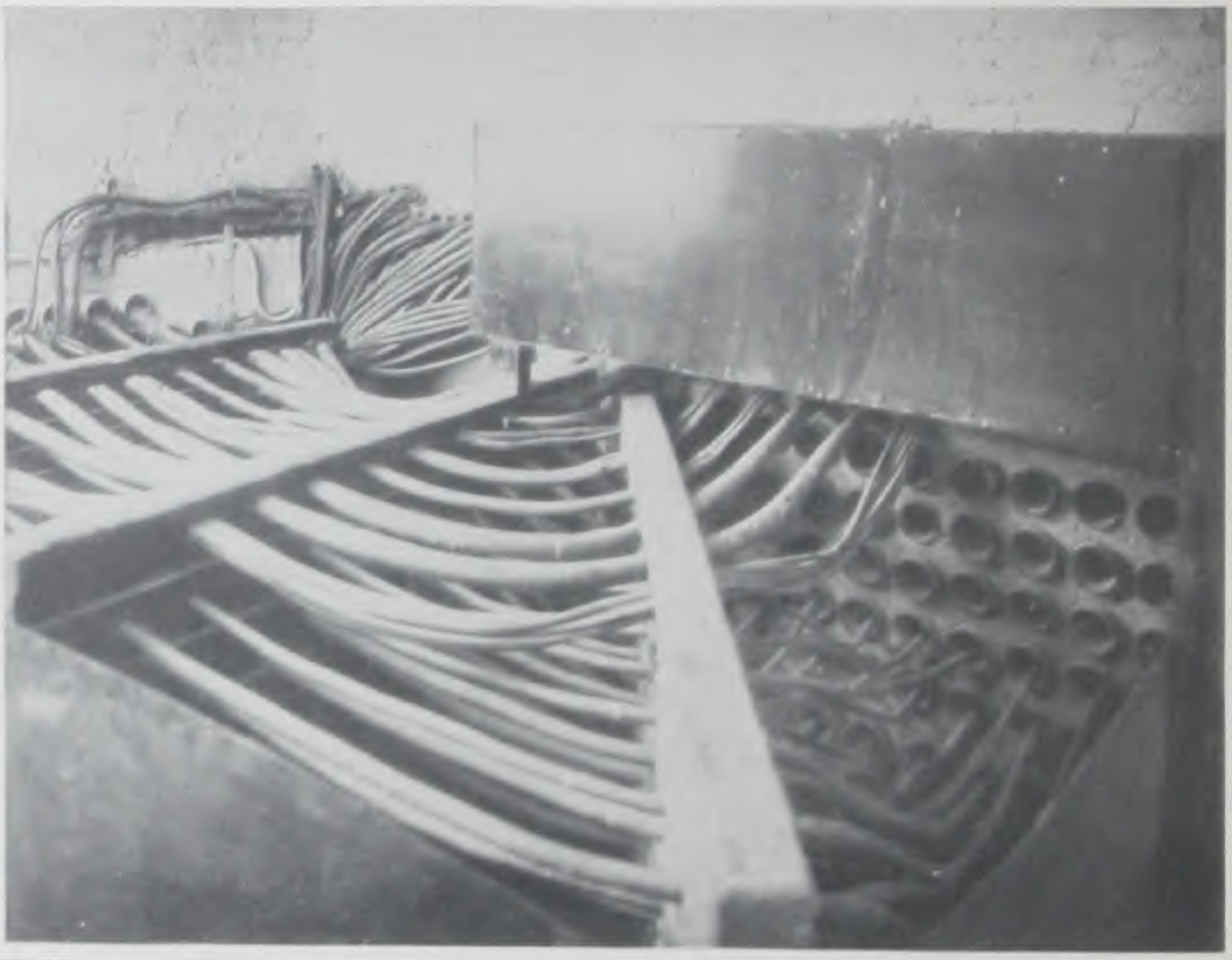


FIG. 50.—Manhole No. 6. Completed.

In the Prudential portion the panels, being designed to meet the maximum condition as explained above, are in some cases quite large, as many as sixty-six branch-circuit switches being provided in the general section alone. The boxes to contain these panels, together with the low extension compartments, were generally constructed of sheet steel 3/16 in. thick reinforced with angle-iron frames and corners and corner gusset plates. The boxes extend down to the steelwork framing of the shafts so that the distributing conduits can be brought into the face of the box without turning up. This arrangement provides a pull-space in the lower part of the box which can be exposed by remov-

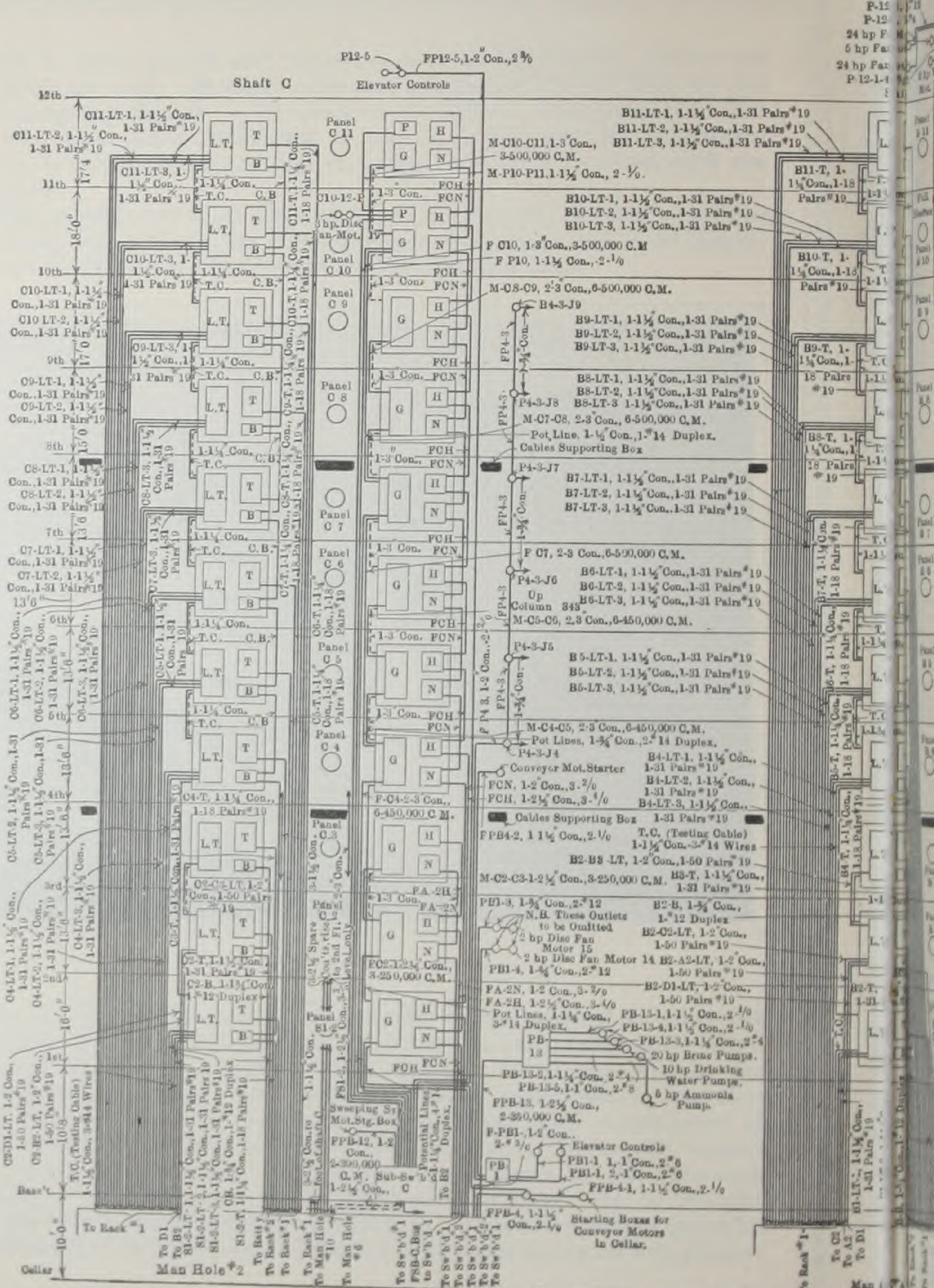
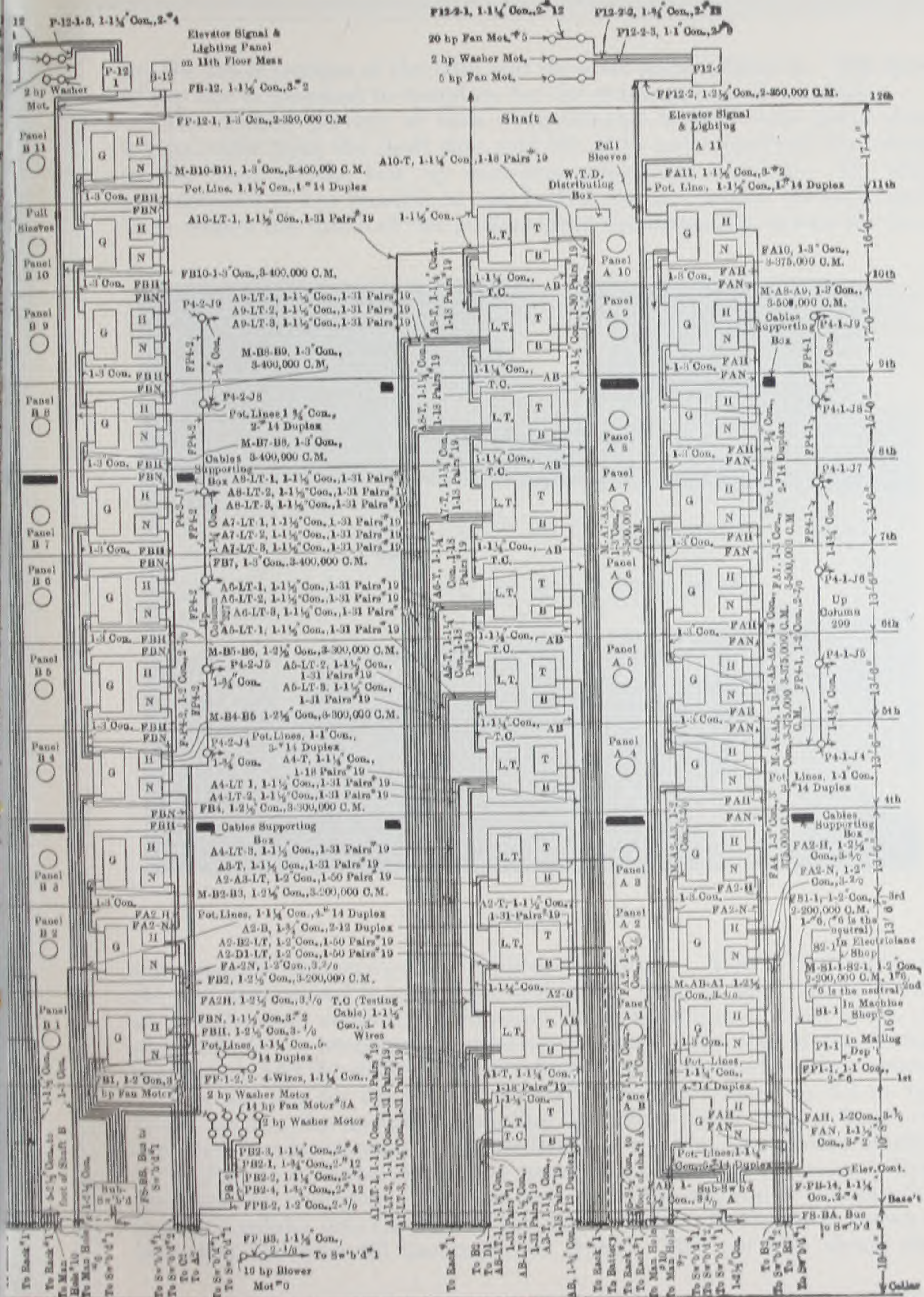


Fig. 53.—Riser Di



Shafts *A*, *B*, and *C*.

ing the lower portion of the trim and the steel plate behind it. The face of the box is punched to template for the entering branch conduits.

The central portion of each compartment behind each panel slab is removable from the shaft side, and the slabs are supported 4 in. clear of the back of the box by cast-iron adjustable supports. By this arrangement it was possible to run branch circuits behind the slabs and thus reduce the width of the gutters since the dimension across the box

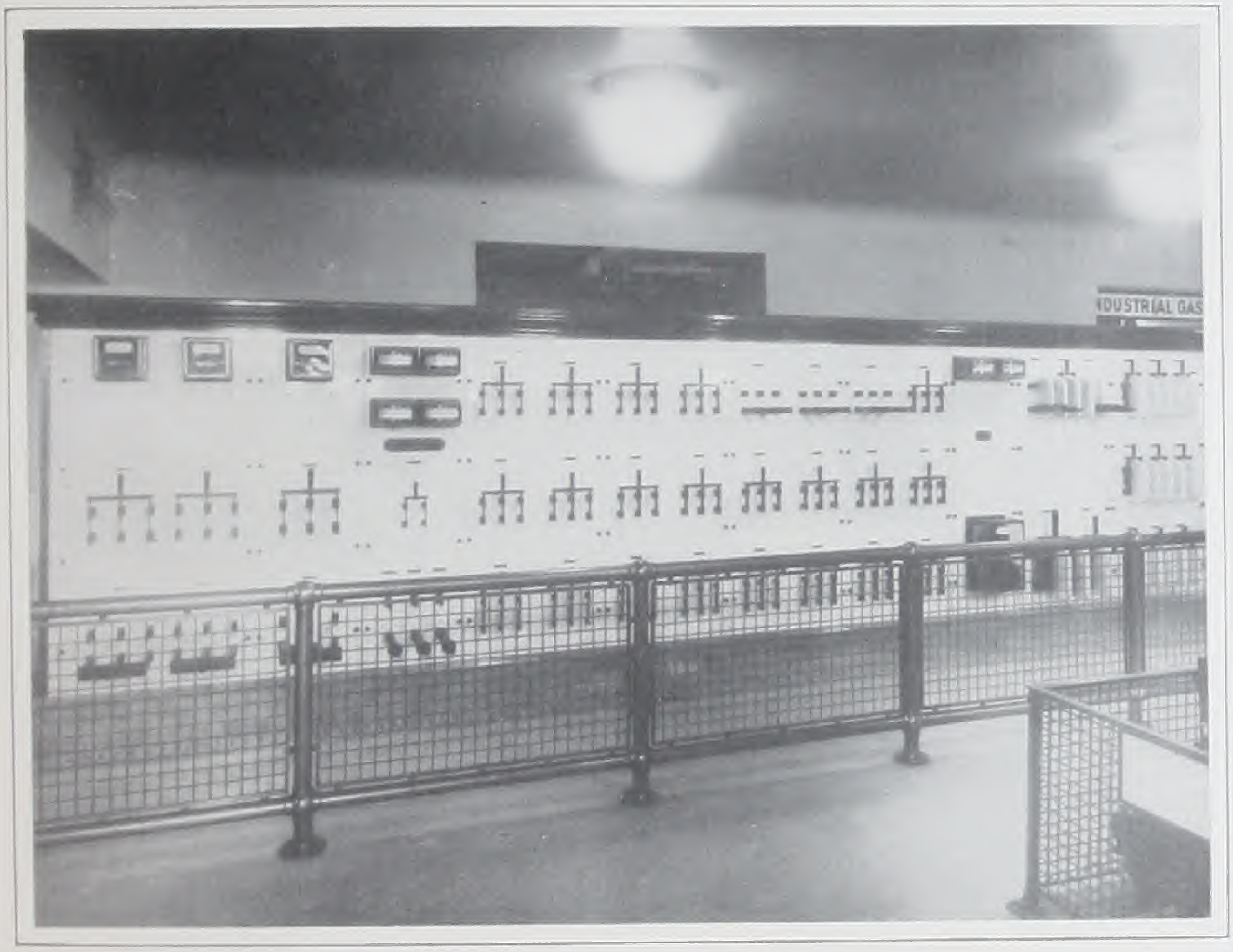


Fig. 51.—Switchboard No. 2.

was generally determined by building conditions. This added depth of the box also caused it to project sufficiently back of the framing beam so that the riser conduits could enter the box bottom without bends or short offsets—a necessary precaution in view of the size of the feeder conductors and the difficulty of bending them in the confined box space.

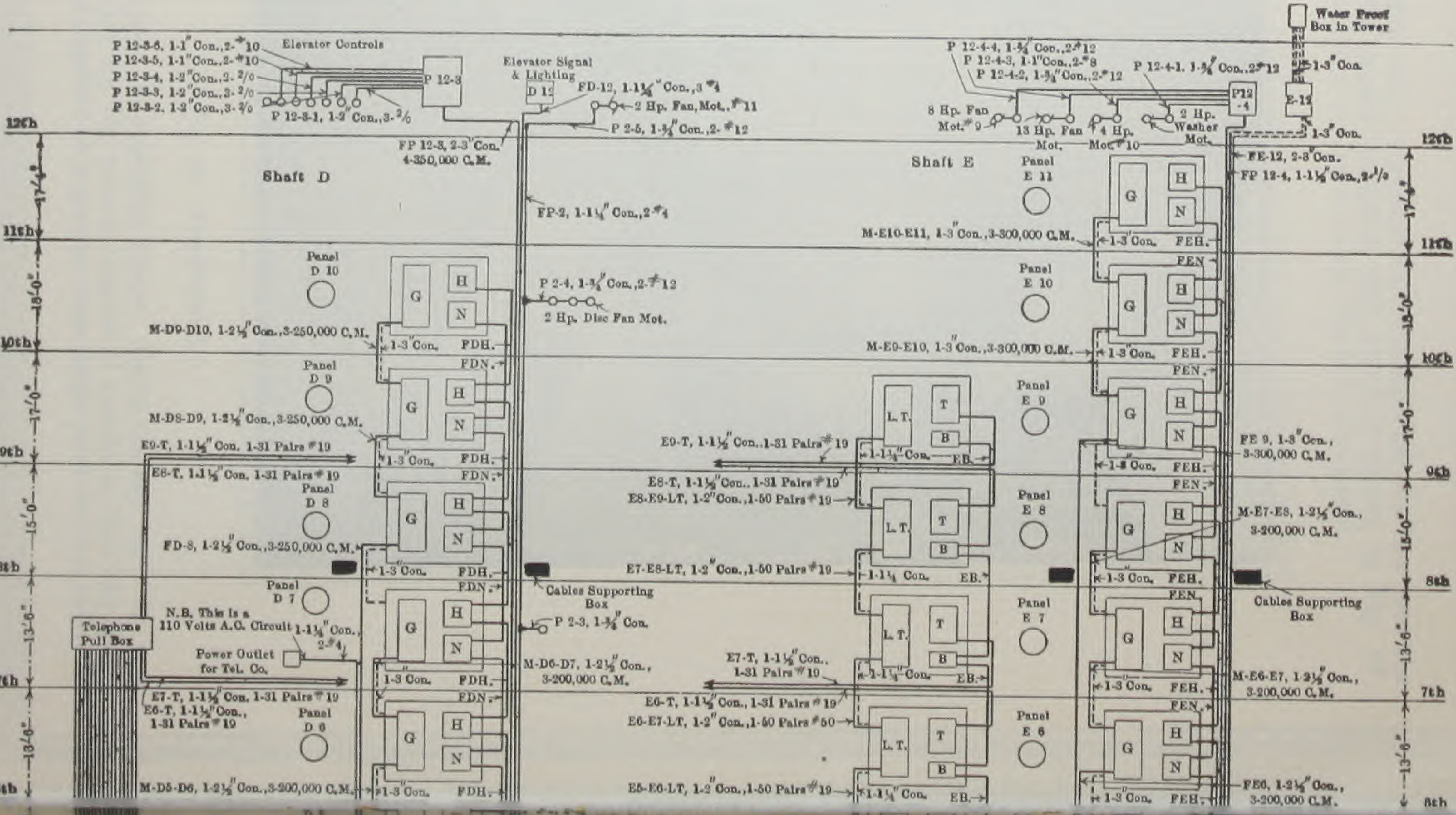
The opening for the box in the shaft furring is framed by 2.5-in. by 2.5-in. angles, the uprights extending from floor beam to floor beam so that each box is supported independently of the 4-in. terra-cotta blocks.

In Fig. 55 is shown one of the panel boxes set up in its frame before the shaft was walled in. This cut also shows the method of running the branch conduits into the face of the box bottom. In Fig. 56 is shown a box after the floor fill has been put down. This cut also shows the

removable base plate and a manhole opening through the box into the shaft. A box with panels mounted and wired is shown in Fig. 57. These panels were built by the General Electric Company.

Fig. 55.—Panelboard Box.

In some cases in assembly-rooms, dining-rooms, etc., it was desirable to provide for the remote control of panels so that the lamps could be operated together or in groups from single push-button switches.



Water Proof Box in Tower
P 12-3-6, 1-1" Con., 2-#10
P 12-3-5, 1-1" Con., 2-#10
P 12-3-4, 1-2" Con., 2- 2/0
P 12-3-3, 1-2" Con., 3- 2/0
P 12-3-2, 1-2" Con., 3- 2/0
P 12-3-1, 1-2" Con., 3- 2/0
Elevator Controls
P 12-3
Elevator Signal & Lighting
D 12
FD-12, 1-1¼" Con., 3 #4
2 Hp. Fan, Mot., #11
P 2-5, 1-¾" Con., 2-#12
FP 12-3, 2-3" Con. 4-350,000 C.M.
P 12-4-4, 1-¾" Con., 2-#12
P 12-4-3, 1-1" Con., 2-#8
P 12-4-2, 1-¾" Con., 2-#12
P 12-4-1, 1-¾" Con., 2-#12
P12 -4
E-12
1-3" Con.
8 Hp. Fan Mot. #9
13 Hp. Fan Mot.
4 Hp. Mot. #10
2 Hp. Washer Mot.
FE-12, 2-3" Con.
FP 12-4, 1-1½" Con., 2-2/0
12th
11th
10th
9th
8th
7th
6th
17'-6"
18'-0"
17'-0"
15'-0"
13'-6"
Shaft D
Shaft E
FP-2, 1-1¼" Con., 2-#4
Panel D 10
Panel D 9
Panel D 8
Panel D 7
Panel D 6
Panel E 11
Panel E 10
Panel E 9
Panel E 8
Panel E 7
Panel E 6
G
H
N
FDH.
FDN.
FEH.
FEN.
L. T.
T
B
EB.
1-3" Con.
1-1¼" Con.
P 2-4, 1-¾" Con., 2-#12
2 Hp. Disc Fan Mot.
M-D9-D10, 1-2½" Con., 3-250,000 C.M.
M-D8-D9, 1-2½" Con., 3-250,000 C.M.
E9-T, 1-1½" Con. 1-31 Pairs #19
E8-T, 1-1½" Con. 1-31 Pairs #19
FD-8, 1-2½" Con., 3-250,000 C.M.
M-E10-E11, 1-3" Con., 3-300,000 C.M.
M-E9-E10, 1-3" Con., 3-300,000 C.M.
E9-T, 1-1½" Con., 1-31 Pairs #19
E8-T, 1-1½" Con., 1-31 Pairs #19
E8-E9-LT, 1-2" Con., 1-50 Pairs #19
FE 9, 1-3" Con., 3-300,000 C.M.
M-E7-E8, 1-2½" Con., 3-200,000 C.M.
E7-E8-LT, 1-2" Con., 1-50 Pairs #19
Cables Supporting Box
P 2-3, 1-¾" Con.
M-D6-D7, 1-2½" Con., 3-200,000 C.M.
Telephone Pull Box
N.B. This is a 110 Volts A.C. Circuit 1-1¼" Con., 2-#4
Power Outlet for Tel. Co.
E7-T, 1-1½" Con. 1-31 Pairs #19
E6-T, 1-1½" Con., 1-31 Pairs #19
E7-T, 1-1½" Con., 1-31 Pairs #19
E6-T, 1-1½" Con., 1-31 Pairs #19
E6-E7-LT, 1-2" Con., 1-50 Pairs #50
M-E6-E7, 1-2½" Con., 3-200,000 C.M.
M-D5-D6, 1-2½" Con., 3-200,000 C.M.
E5-E6-LT, 1-2" Con., 1-50 Pairs #19
FE6, 1-2½" Con., 3-200,000 C.M.

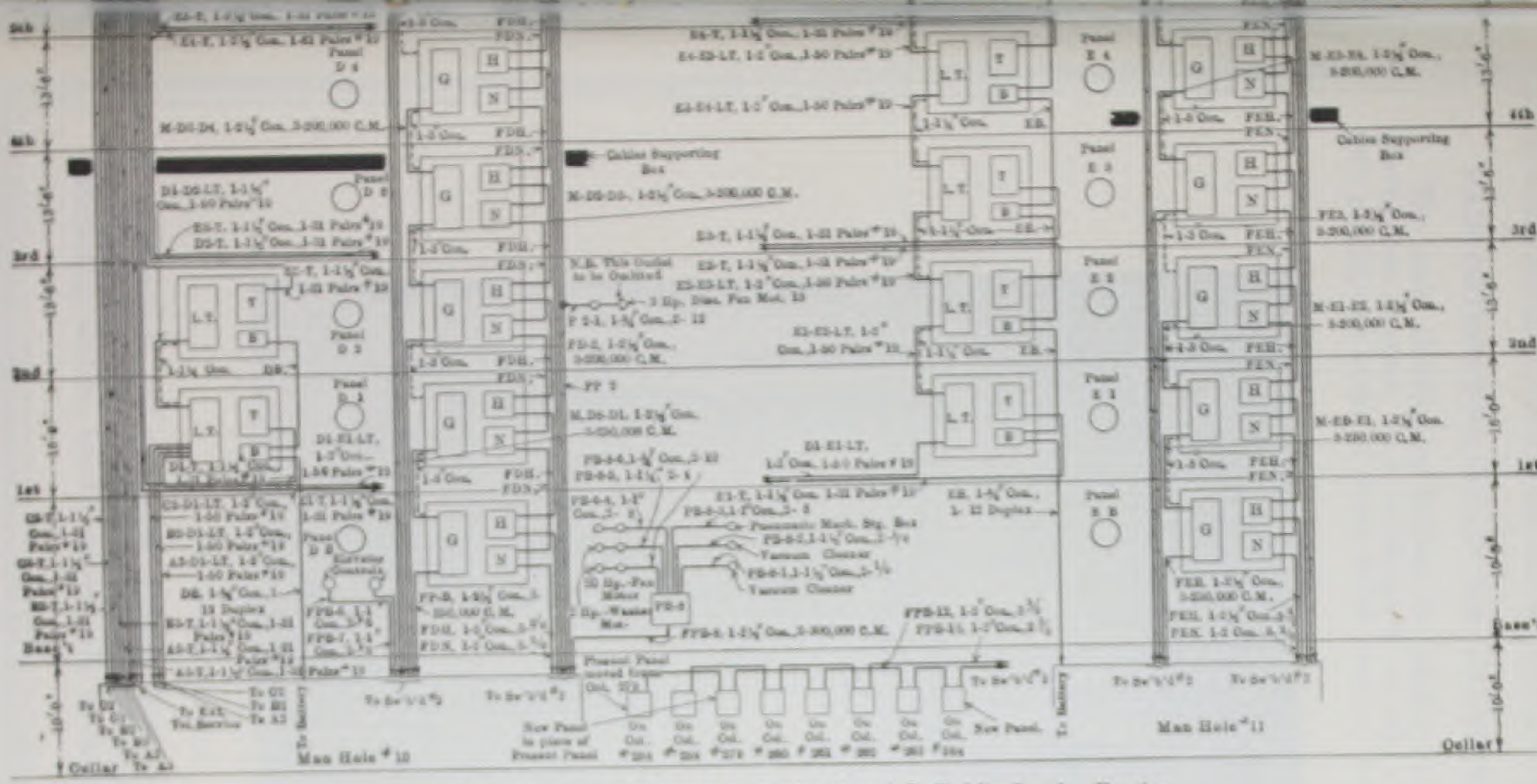


FIG. 54.—Riser Diagram. Shafts *D* and *E*, Public Service Portion.

MAIN DISTRIBUTING SYSTEM FOR TELEPHONES AND SIGNALING.

The main distributing system for telephones and signaling, or the low-tension system, as it is designed on the work, is centralized at two points, one south of Bank Street serving the Prudential Main and

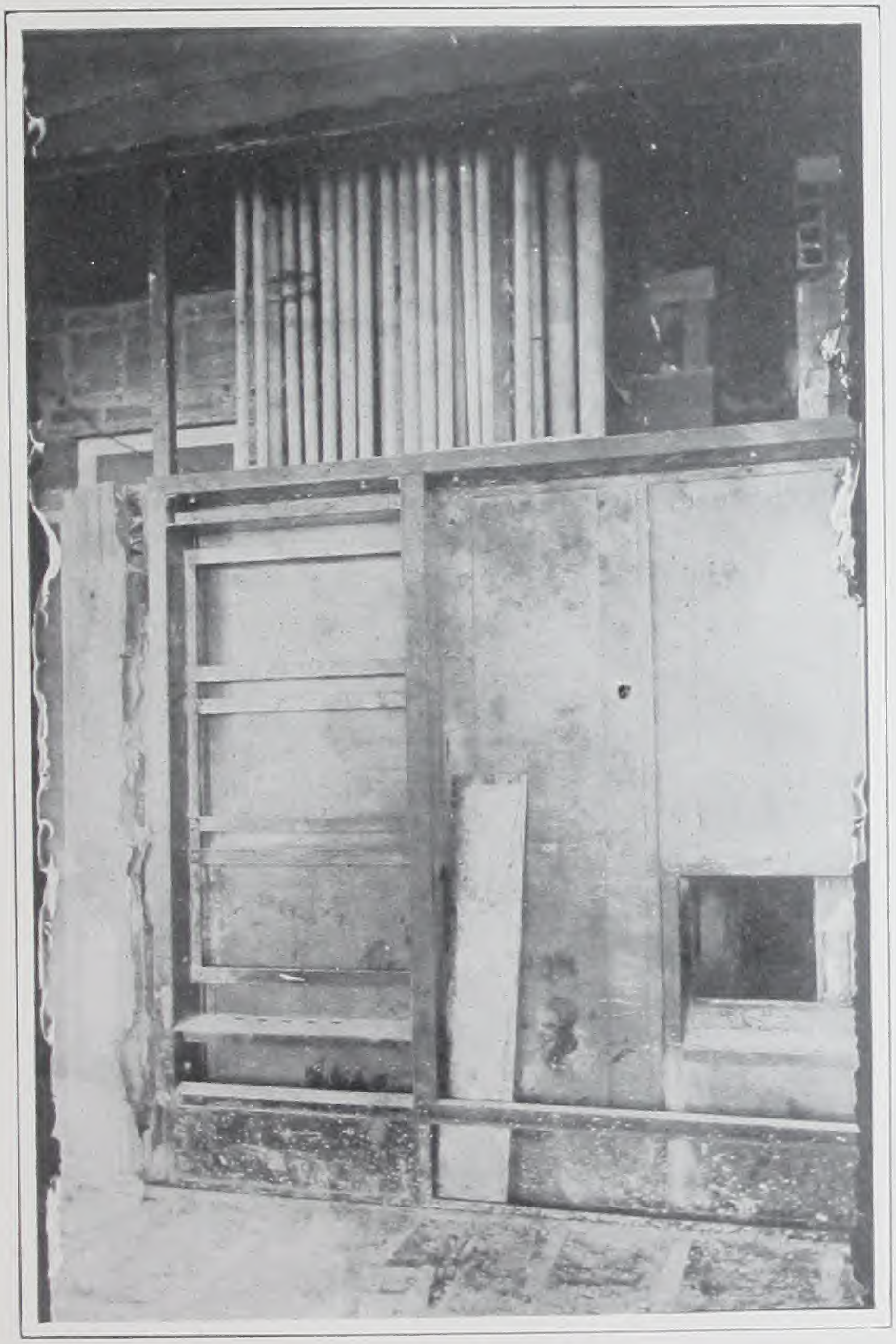


FIG. 56.—Panelboard Box.

West Buildings, and one north of Bank Street serving the North Building, North Building additions and the Northwest Building. These two distributing centers, known respectively as rack No. 2 and rack No. 1,

are tied together by trunk cables run through the main passage tunnel under Bank Street. Riser cables are run from rack No. 1 through the subway system in the cellar of the North Building addition and up the riser shafts to the several main-floor junctions. The riser cables from

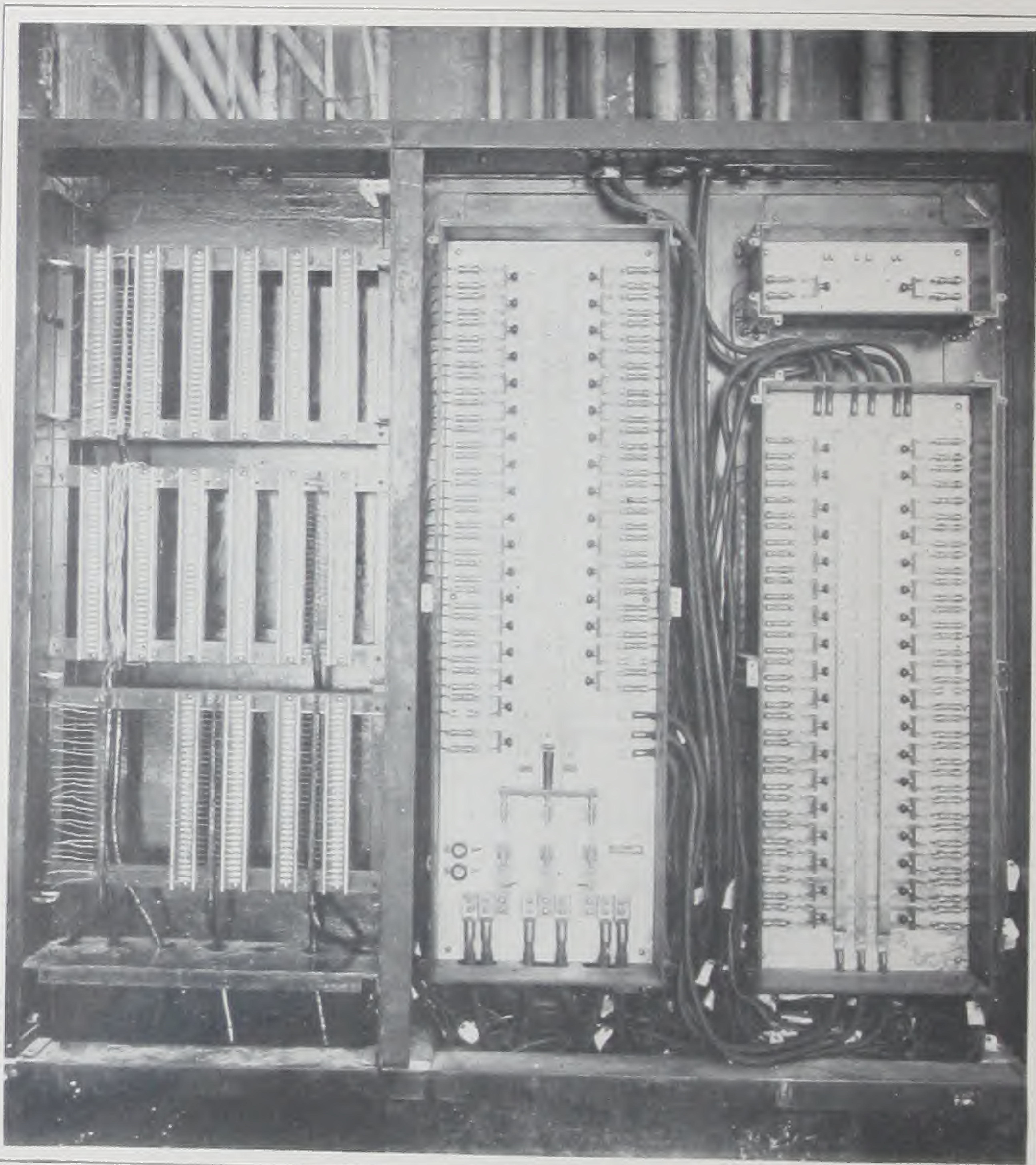


FIG. 57.—Panelboard and Main Floor Junction.

rack No. 1 to the floor junctions in the North Building and Northwest Building are run through the cellars and tunnels overhead as convenience dictated and hung by special hangers, so that any one cable can be entirely removed without interfering with any other cable. These cables pass through junction boxes at the foot of the riser shaft, where they

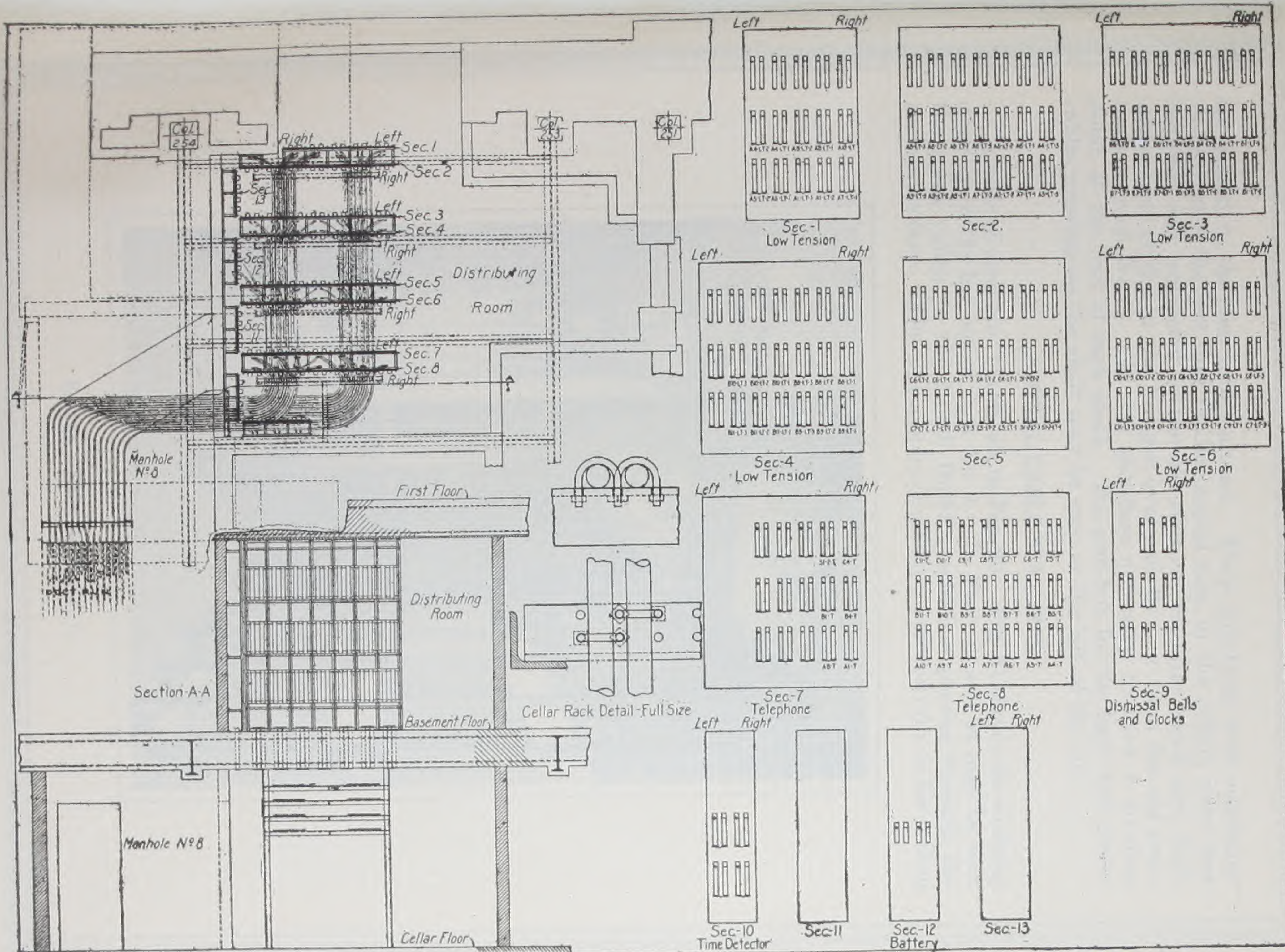


Fig. 60.—Details of Rack No. 1.

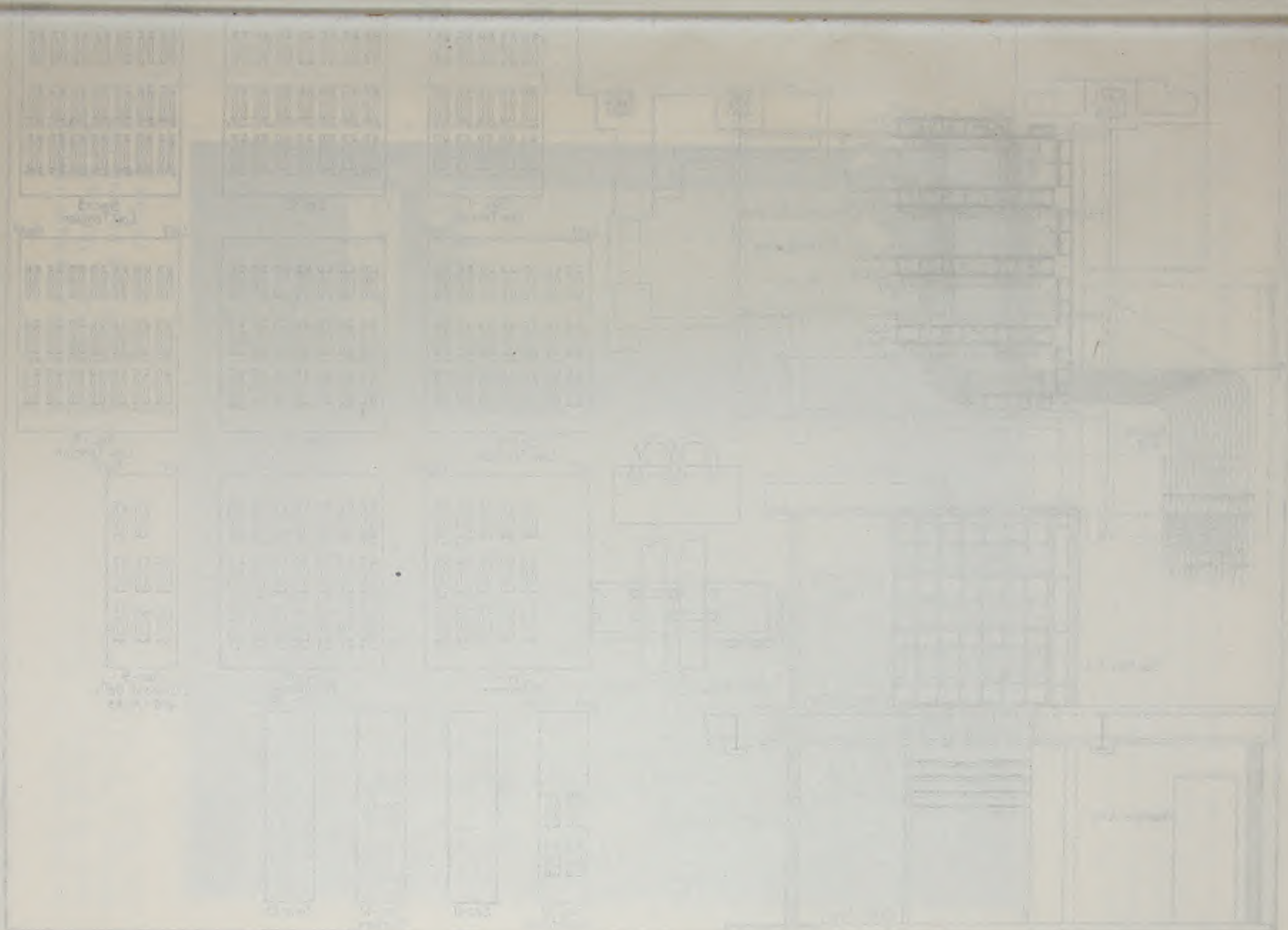


Fig. 90.—Layout of Bank No. 1

are joined to the riser cables proper. These junctions were necessary on account of the fact that the horizontal runs in the cellars were first installed and connected to the old riser cables, after which new shaft cables were pulled in and bridged over pair by pair from the old junctions to rack No. 1. It was therefore necessary to have a dividing point at the foot of each shaft. The pull-box for the light and power cables running up the shaft may be seen at the left of the cut.

SPECIAL CABLE FEATURES.

A view of rack No. 1 is shown in Fig. 60. Fig. 61 shows the working drawing of the lay-out of rack No. 1. In Figs. 60 and 61 may be seen the rising cables to the North Building addition passing through the rack-room floor. The pipe nipples there shown extend only to the ceiling

Fig. 61.—Rack Room No. 1.

of the cellar space beneath the rack-room known as manhole No. 8 (see Fig. 9), the cables being run along this ceiling in long steel pans hung under the rack sections. These pans join at one end to a cross-pan which serves to carry the cables to a steel pull-box capping the end of the subway where it enters this manhole. This special arrangement was made to avoid the main elevator trunk pipes and other pipes passing through the manhole.

MULTIPLICITY OF THE SERVICE DEMANDS.

The main racks are divided into two separate sections for telephones, annunciators, etc., clocks, dismissal bells, battery service, fire alarms and watchman's time detectors. Separate rising cables and trunk cables for these several services are used, the rising cables for telephones and annunciators terminating in corresponding separate sections of the floor junctions. The street-service telephone junction is in the cellar

FIG. 69.—Part of a Typical Floor, Showing Method of Lighting Desks.

of the Prudential Building and is connected to the main racks by trunk cables. A general diagram of the riser system is shown in Figs. 53 and 54. Separate lines for testing and for portable telephones for

use while connections are being made connect the racks with all floor junctions. The rising clock cables and dismissal bell cables are run through separate smaller junctions on each floor, the dismissal bells being mounted on the junction covers. Clocks have individual outlets connected to these junctions.

DISMISSAL BELLS.

All dismissal bells are controlled, either individually, floor by floor, or all at once, as desired, from a dismissal bell-board located in the supervisor's office in the Main Building. The clocks are controlled by a master clock in the real-estate department on the eleventh floor of the North Building, the master clock junction being connected directly to rack No. 1, shown in Fig. 61, in the issue of Feb. 24. The watchman's recording clock is similarly located and similarly connected.

Each secondary-time clock is connected to the rack by a separate pair of wires in the clock cables. The clocks are connected in series of not over ten by bridging the terminal strips in the racks, and each series is cross-connected to a pair in the main clock cable to the master clock. Adjustable resistances are provided in each pair at the master clock

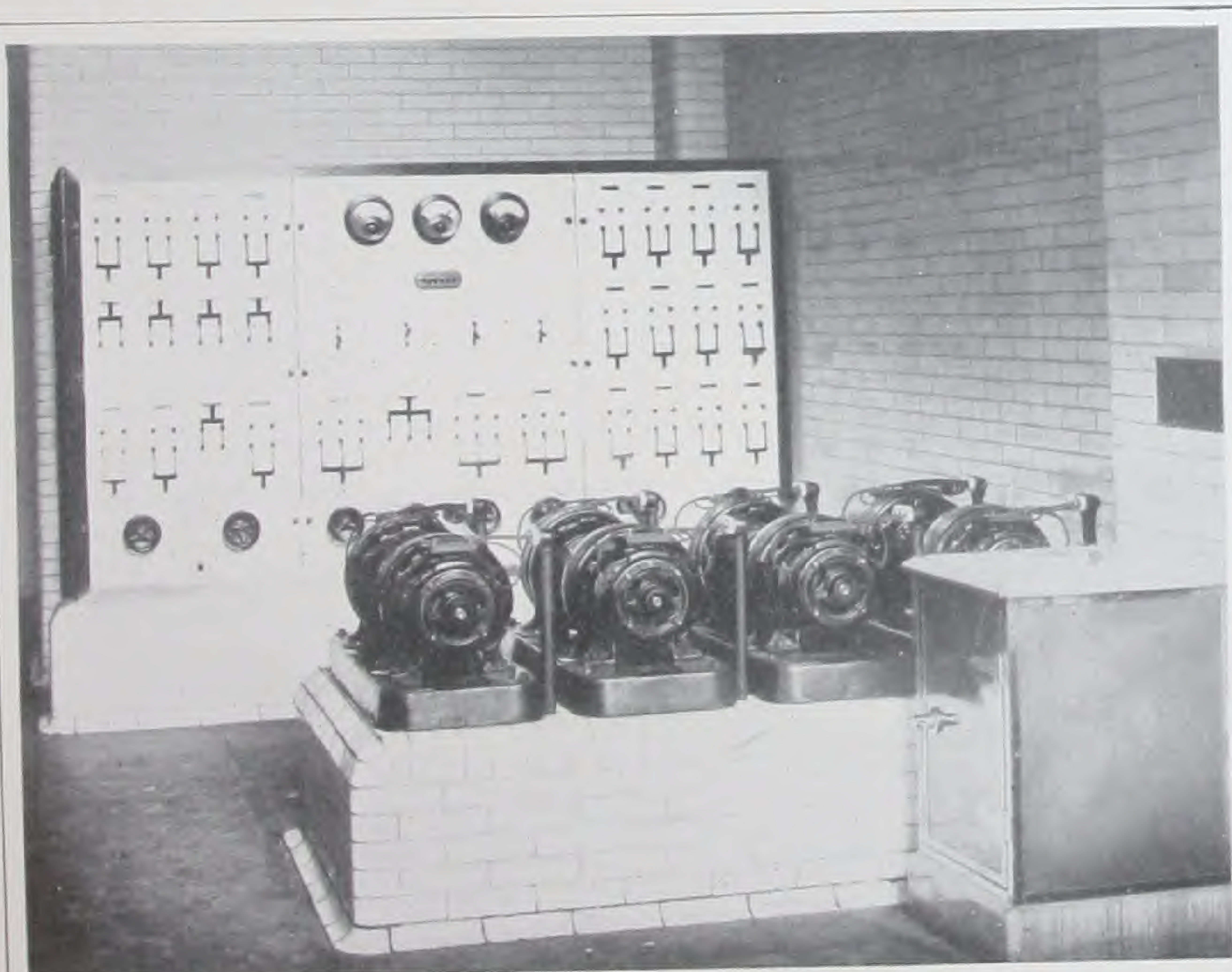


FIG. 70.—Battery Plant.

junction, so that the total resistance of each series may be maintained constant when one or more clocks are cut out for adjustment or repairs. A multiple sector plug switch and contact key are also provided in this junction and so arranged that by inserting the plug and pressing the key any number of times all the secondary clocks in the system may be set ahead an equivalent number of periods.

OPERATION OF ANNUNCIATORS.

Each cable in each type of service is numbered and tagged at each end and in all pull-boxes and is provided with a special terminal strip at the two junction points where it begins and ends. Telephone cables are connected pair by pair on the same strip. Annunciator cables are connected to a pair of strips at each end, one positive and one negative. This is done so that when changes are made there is little chance of "ringing up" by accidentally bridging between terminals by a slip of

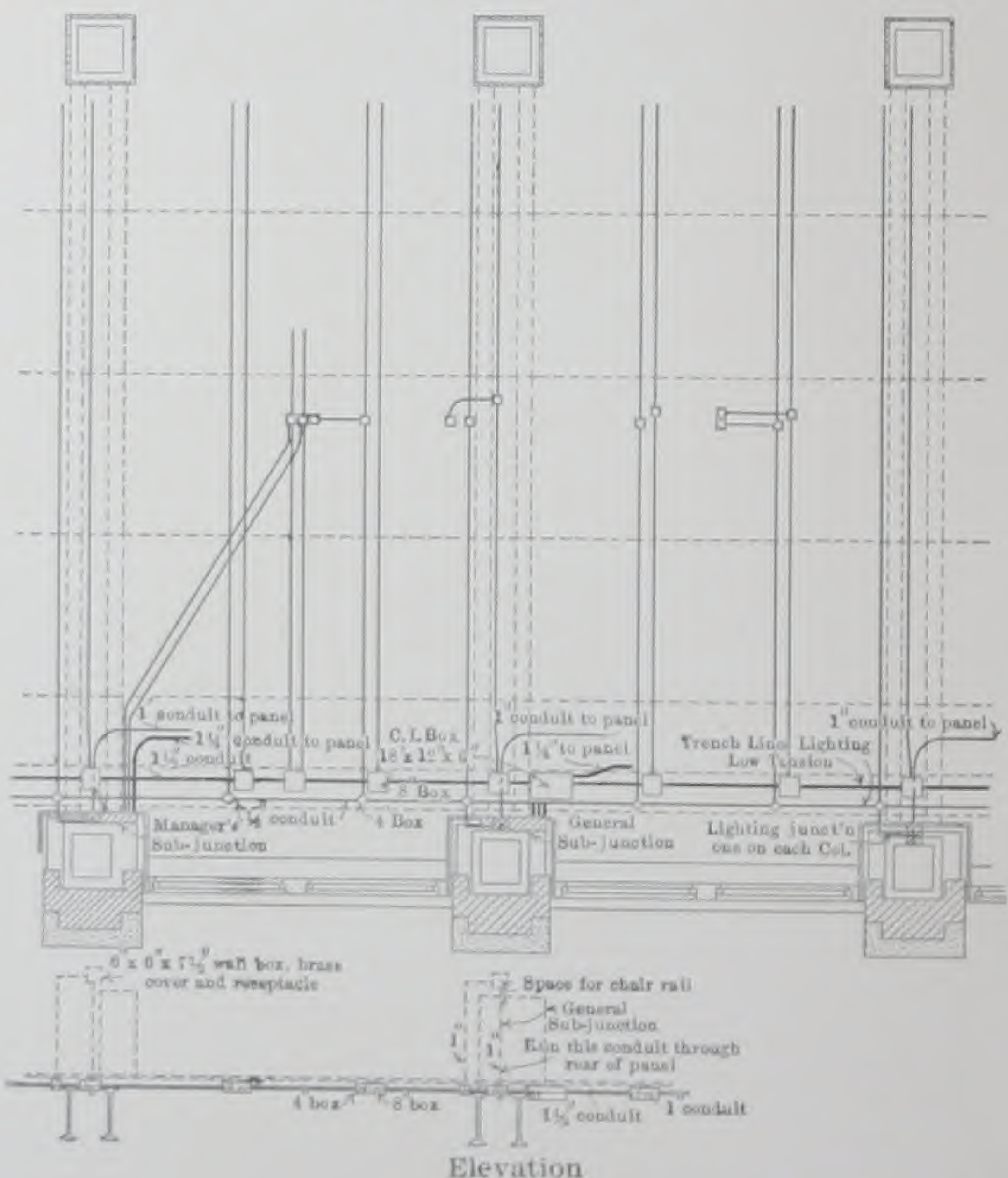


Fig. 71.—Under-Floor Wiring.

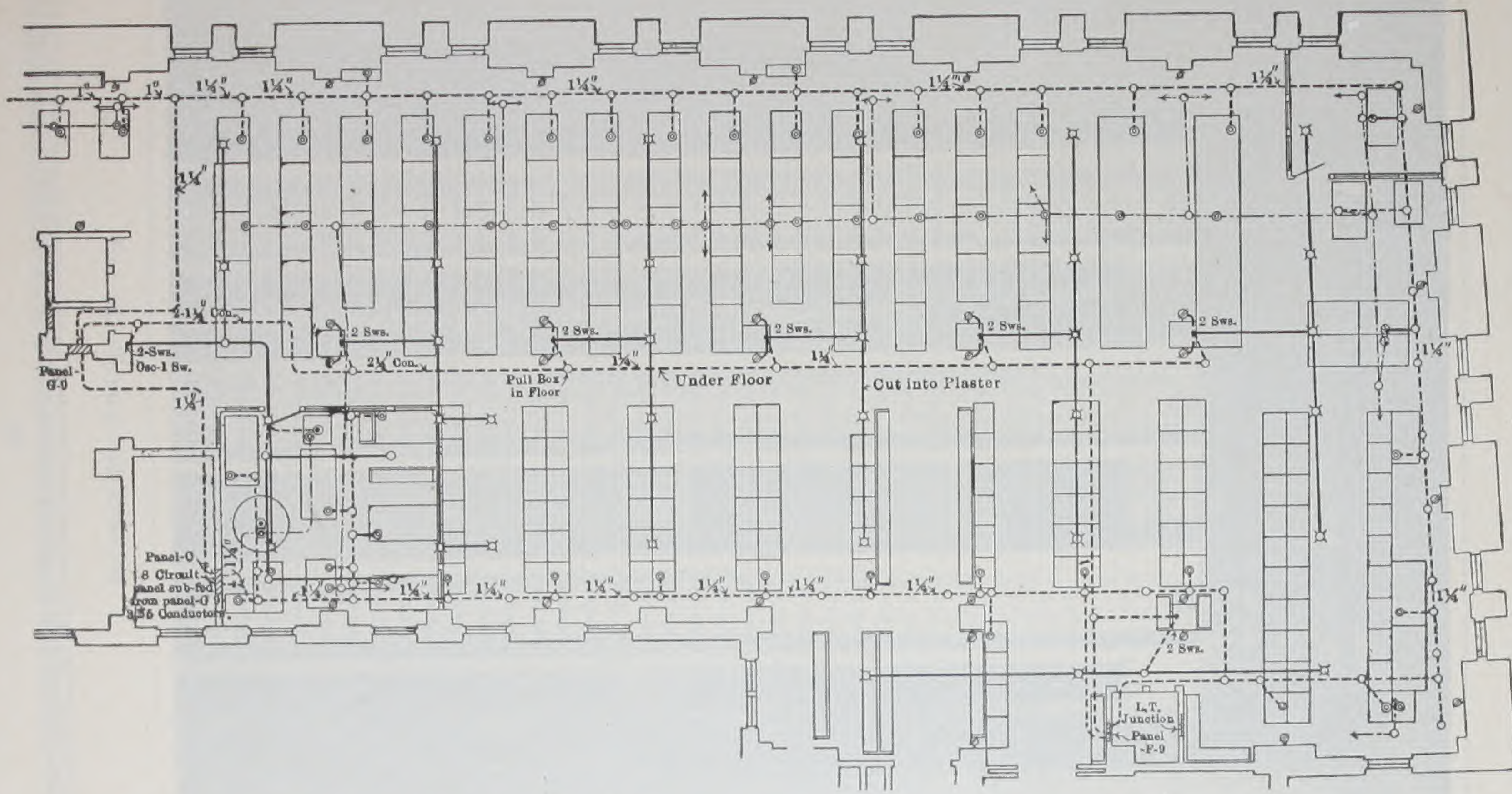


FIG. 72.—Typical Revised Floor Layout in Old Building.

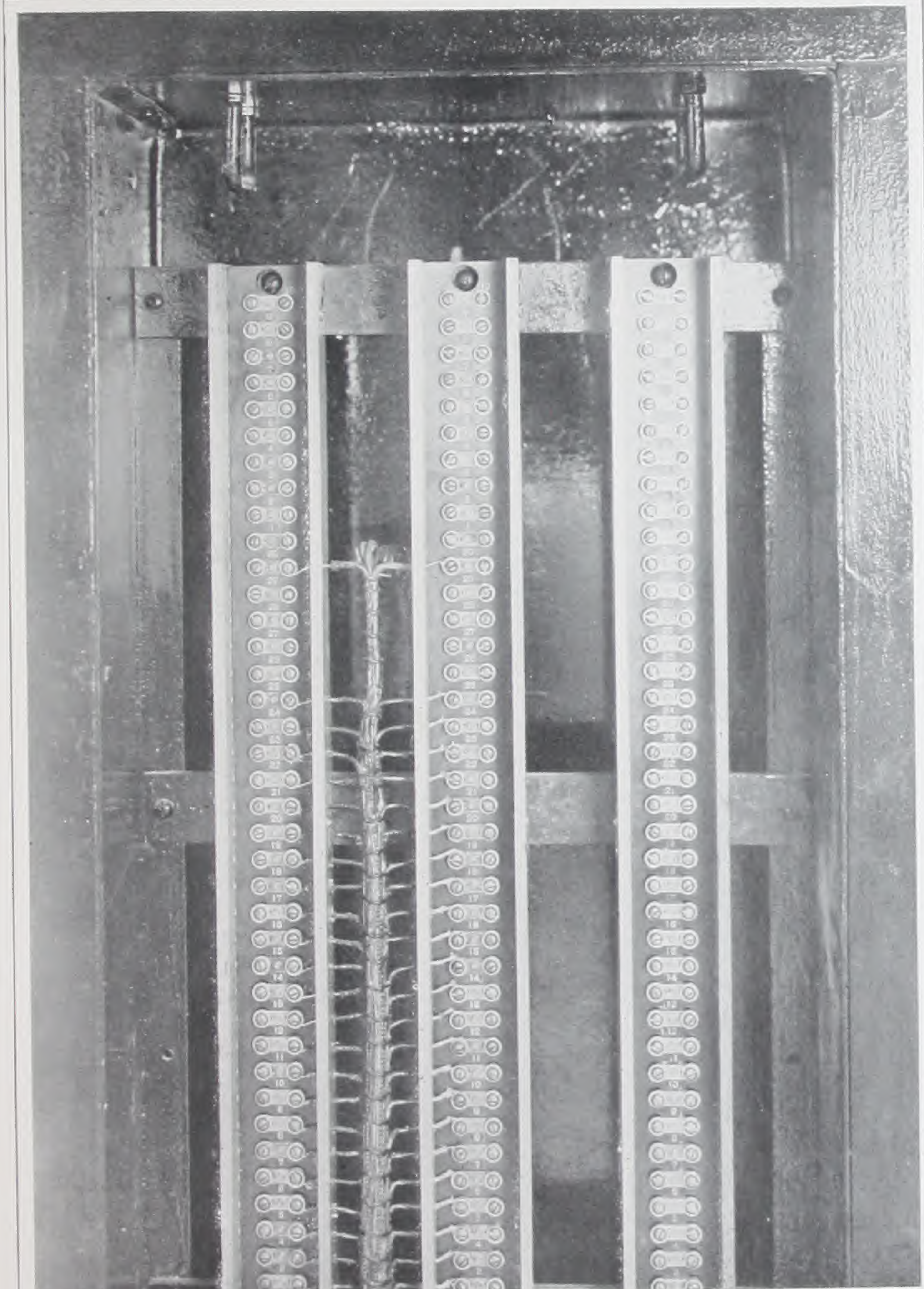


Fig. 73.—Typical Sub-Junction.

the tool used to loosen the contact screw. The number of each cable and its service are stenciled on the terminal block, and a record form is kept for each block showing what cross-connections have been made to it and where such connections go. These forms are kept in the racks and junctions, and duplicate records are entered in a log book. The forms are printed on specially calendered paper, the record of cross-connection being entered up in pencil, which can be easily erased if the connection is changed. By this general arrangement all cross-connections are confined to the racks and to the floor junctions, the system being perfectly elastic at these points. Extensive changes in the routing of connections can be made expeditiously and with a minimum of confusion.

The cables for telephones and annunciators consist of standard telephone switchboard cable lead-sheathed, using No. 19 conductors covered with double silk and cotton. The cables for clocks, dismissal bells, watchman's time detector, fire alarms and battery service are rubber-insulated; they are lead-covered only when they run through the subway system.

The interconnection strips employed were designed for this work, using as a basis a type of strip utilized in the old work and manufactured by the Prudential company in its own shops. The general character of the strip is well illustrated in Fig. 73. It is provided with removable maple form strips and a cover hooking on to the form strips. The cover is not shown in Fig. 73. A detail of this strip is shown in Fig. 75.

To furnish energy for operating annunciators and the various signaling systems, duplicate 200-watt, 24-volt Holtzer-Cabot motor-generator sets have been installed. These sets are mounted in company with a similar duplicate set for operating the elevator-signal system on a raised foundation in the new engine-room. A view of these sets is shown in Fig. 70, together with the switchboard controlling the sets and the "battery feeders." The word "battery" is here a misnomer, as there are no batteries connected with the system.

The "battery" feeders are run from this board to the several racks and main riser junctions, where they terminate in connection strips, each of which consists of a single bus mounted on a composition block with removable form strips. The feeders are connected through single-pole knife switches mounted on the block so that they may be cut out when desired.

Rising feeders run up the shafts from the rack and main-junction "battery" strips to similar strips in the main-floor junctions. Branch lines are taken from the floor-junction strips to the sub-junction strips in each sub-junction on each floor.

In general, throughout the entire "battery" system, all positive strips and wires are colored black, all negative strips and wires are colored white, and they are known respectively by the euphonious names of "black batt" and "white batt."

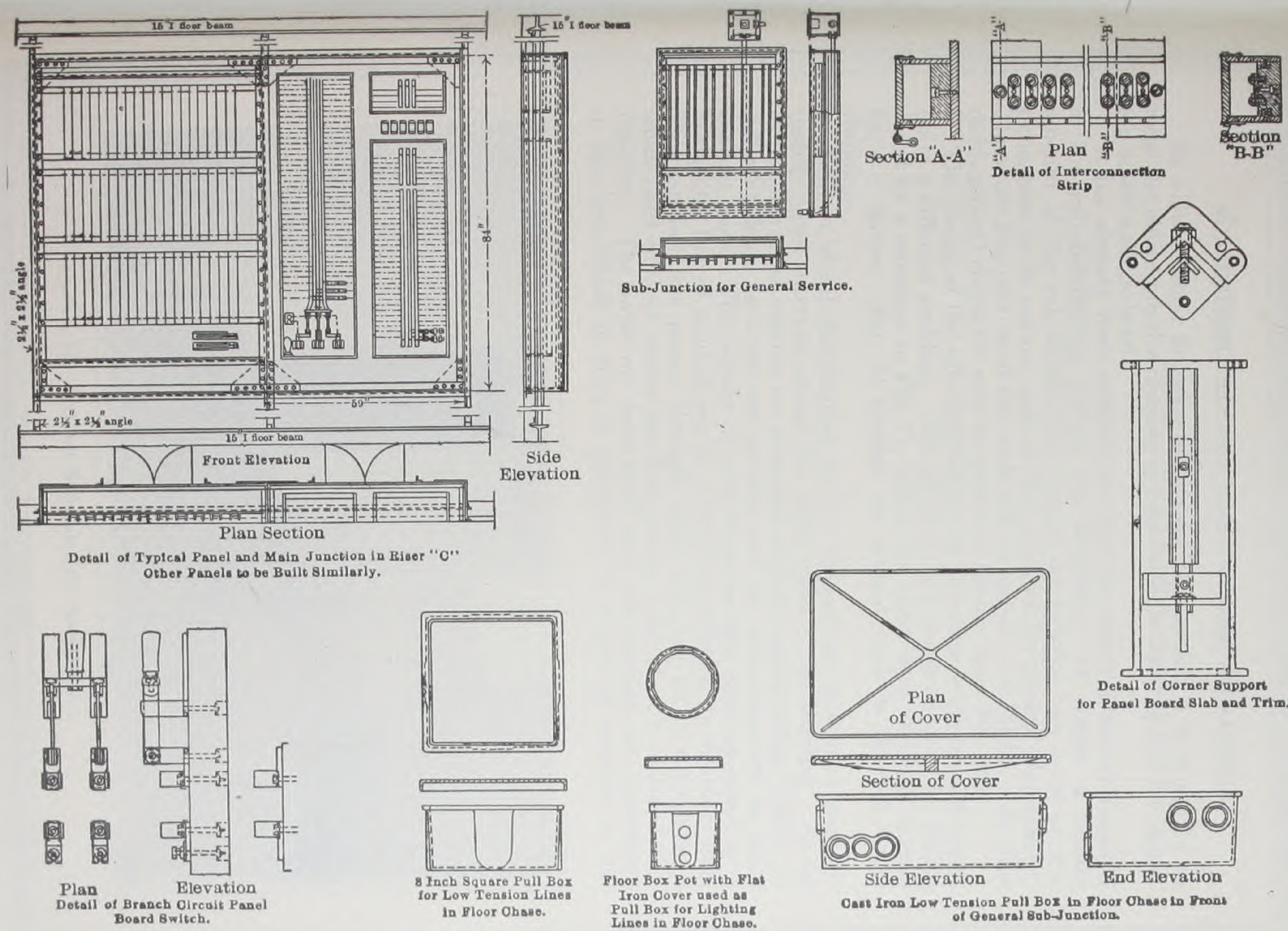


Fig. 75.—Details of Sub-Junction.

In view of their intimate structural relationship it is necessary to treat the entire sub-distributing system both for lighting and for signaling under a single head.

It has already been pointed out that the essential feature required of the sub-distributing system was flexibility. Of course, a certain amount of the sub-distribution system for lighting was more or less permanent in its nature, such as that required for general illumination. Therefore this portion of the work will be passed over briefly. An idea of its general character may be gathered readily from Fig. 69.

The design of the sub-distribution for furniture work was, however, quite a different problem. The solution here employed may be understood by a reference to Fig. 71, where the under-floor wiring of typical bays is shown. Fig. 72 typifies the revised work in the old North Building.

Centers of sub-distribution for low tension are located at approximately equal intervals about the outer walls of the building. As far as possible these centers are arranged so that corresponding centers on different floors are over one another and are interconnected by rising conduit lines. The centers on each floor are also interconnected by a horizontal line of conduit run in a trench parallel to the building wall. This conduit line passes through large cast-iron boxes resembling a small-sized sink set under the floor just in front of each center of sub-junction. The home run from each such sub-junction also terminates in this box, which in turn is connected by a nest of conduits to the

Fig. 74.—Typical Sub-Junction Roughed In.

sub-junction itself. A "mangers" sub-junction, roughed in with its special home runs, the junction pot and trench line, is shown in Fig. 74. A typical sub-junction without trim is shown in Fig. 73. The general sub-junction detail is shown in Fig. 75. It is to be noted that the containing cabinet, like the main-floor junction box, extends down to the steel level. A section of the general sub-distribution for low tension is shown diagrammatically in Fig. 76.

ROUTES FOR THE WIRES.

Conduit lines are provided so that wires can be run from any sub-junction to any other sub-junction by any one of several routes, as convenience may dictate; thus: (1) To the main-floor junction, to the main rack, to some other main-floor junction, to the desired sub-junction; (2) by way of the trench conduit to the sub-junction vertically over (or under) the objective sub-junction, down (or up) the sub-junction riser; (3) to the main-floor junction, to a sub-junction vertically over (or under) the objective sub-junction, and, again, down (or up) the inter-sub-junction riser; and so on.

To provide for connections to the sub-junctions from the furniture, the trench line is interrupted approximately every 5 ft. by a small box 8 in. square (see "details," Fig. 75), from which a line is run perpendicular to the outside wall to the central axis of the building, where it is capped (see Fig. 72). If this line is not used it is left under the floor inactive but ready for future use. If this line comes under a desk to which connection is to be made, a pot is inserted in this line under the desk, a floor plate is installed and a conduit extension is run from the floor plate to the desk. If the desk is not directly over the line, but is nearer to it than any other under-floor line, then a blind pot is inserted in the line opposite the desk, and a line is run from this pot to a pot with floor plate under the desk. Since the finished floor runs parallel with the outer walls, such extensions require only the taking up of two or more parallel strips, which, with a little care, can be replaced so as to leave no sign of having been disturbed.

SPECIALLY DESIGNED FLOOR CONNECTIONS.

The floor box used for this purpose is of interest, having been designed for this particular work. The pot is round with flat conduit pads and is set with only approximate regard to leveling or to grades. When the rough floor is laid it is cut roughly to clear the pot by about $\frac{3}{8}$ in. The cast-iron floor ring with pot collar is then put in place, its flange projections resting on the rough floor to which it is screwed or to the pot, as may best suit the case, the only care required being to see that the square floor flange is set square with the finished floor strakes. The top is thus automatically leveled with the floor finish. A cast-iron filling piece and gasket are then set into the floor ring, over which

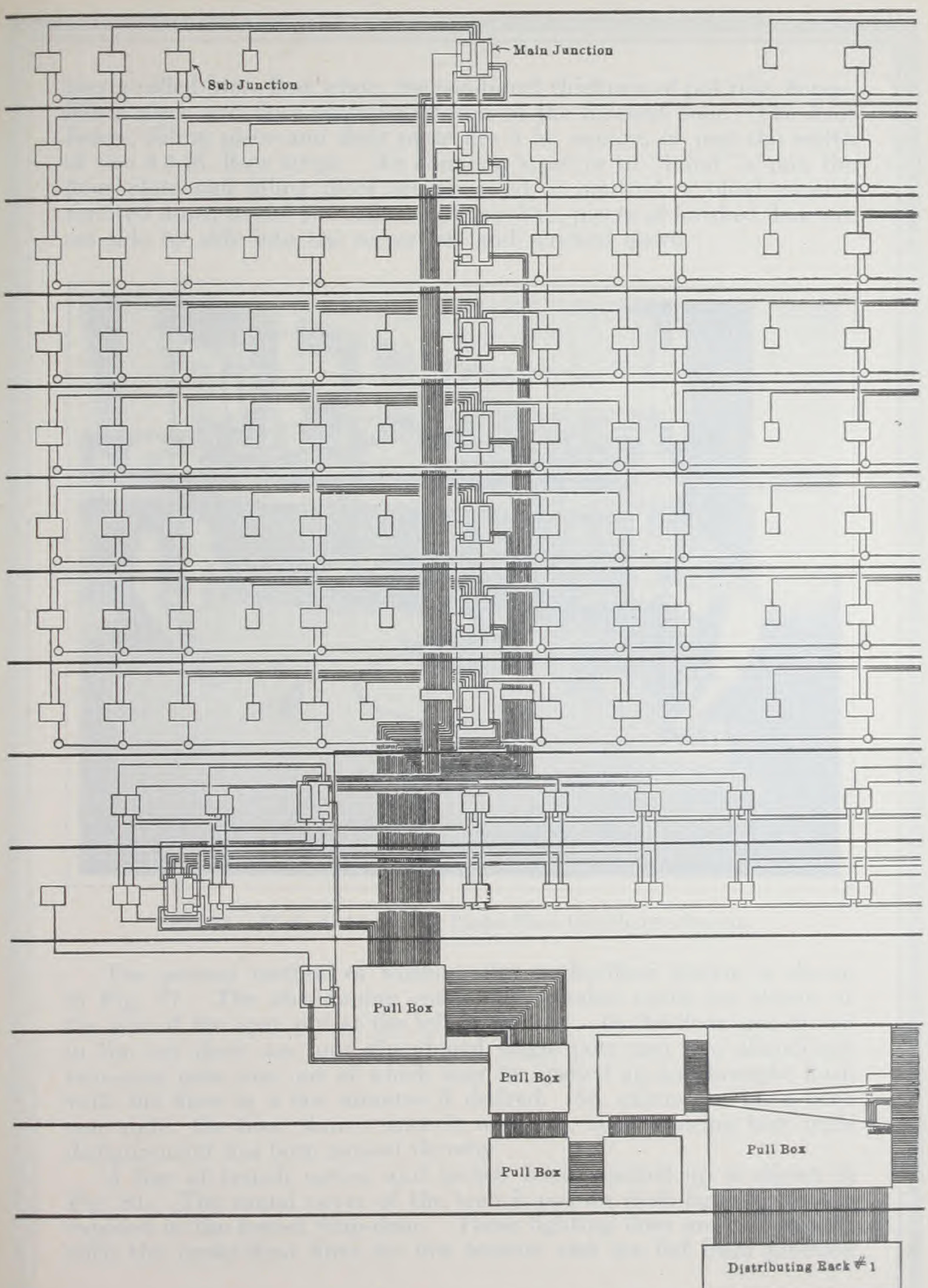


Fig. 76—Low-Tension Riser Diagram.

goes a rolled-brass floor plate, the combined thickness of pot ring, flange, filling piece and floor plate being that of the finished floor. The floor flange, filling piece and floor plate are 5 in. square, or just the width of two 2.5-in. floor strips. To abandon a pot or to "blind" a pot, the floor plate and filling piece are removed or omitted, a blind cover is screwed down to the pot collar, and two 5-in. pieces of finished floor are set side by side into the recess left and screwed down.

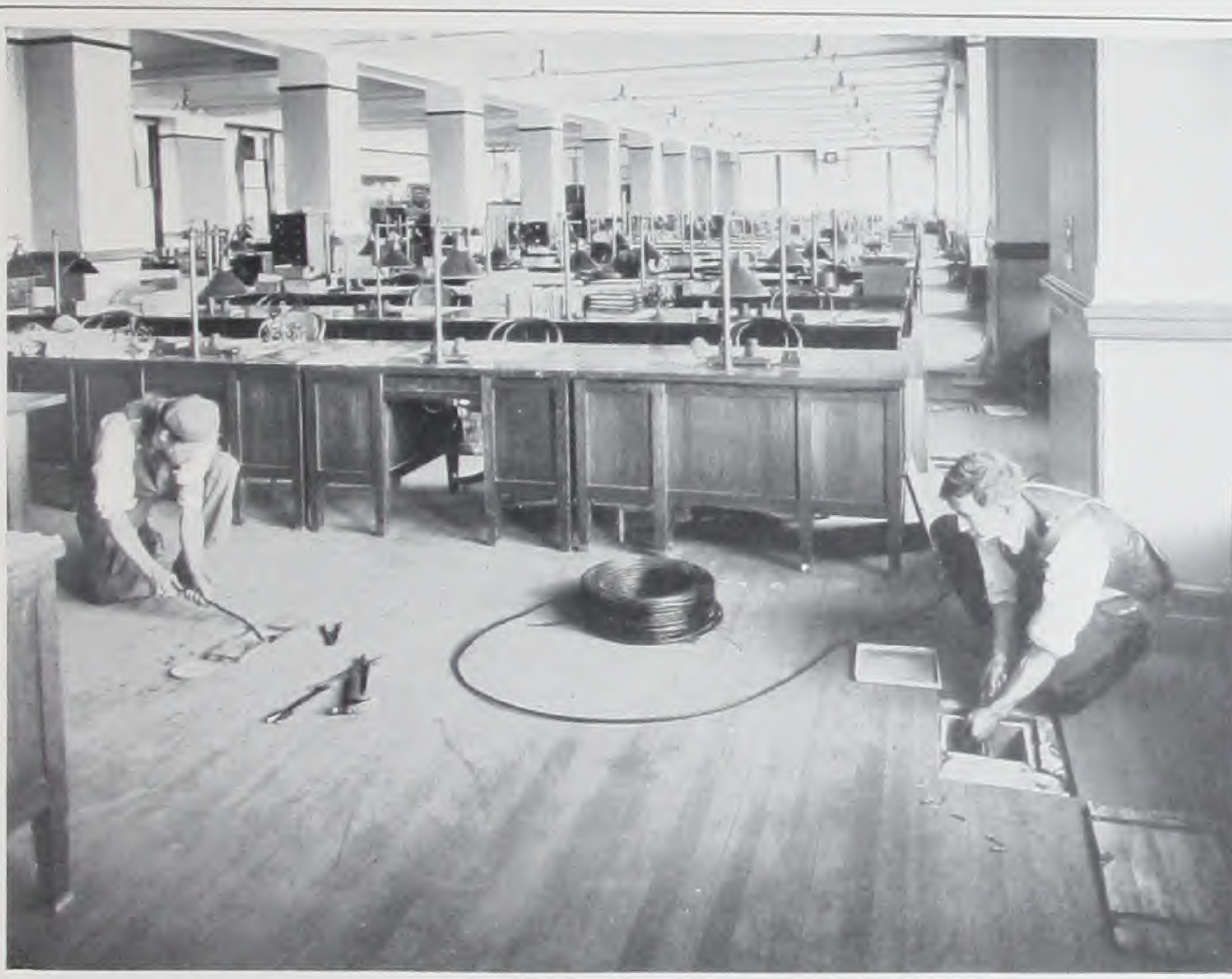


Fig. 77.—Method of Installing Under-Floor Distribution System.

The general method of working this under-floor system is shown in Fig. 77. The abandoning cover and wooden cover are shown at the side of the open pot at the left of the cut. In the floor area shown in the cut there are four abandoned single pots and two abandoned two-gang pots, any one of which may be opened up and brought flush with the floor in a few minutes if desired. Six extensions have been run under the floor shown since it was laid, thus showing how little disfigurement has been caused thereby.

A line of trench covers and trench boxes opened up is shown in Fig. 81. The round cover of the trench pot for desk lighting lines is exposed in the lowest trap-door. These lighting lines are run parallel with the under-floor lines for low tension and are fed from junction

outlets on each pilaster, to each of which three branch circuits are brought from the panelboards. Pots for lighting and low-tension circuits in branch under-floor lines are staggered and drilled for conduits on two levels so that extensions to flush pots under the desks may cross over the through lines. As a matter of interest comparison may be made with Fig. 79, which shows the conduit runs under floors in the old building before remodeling.

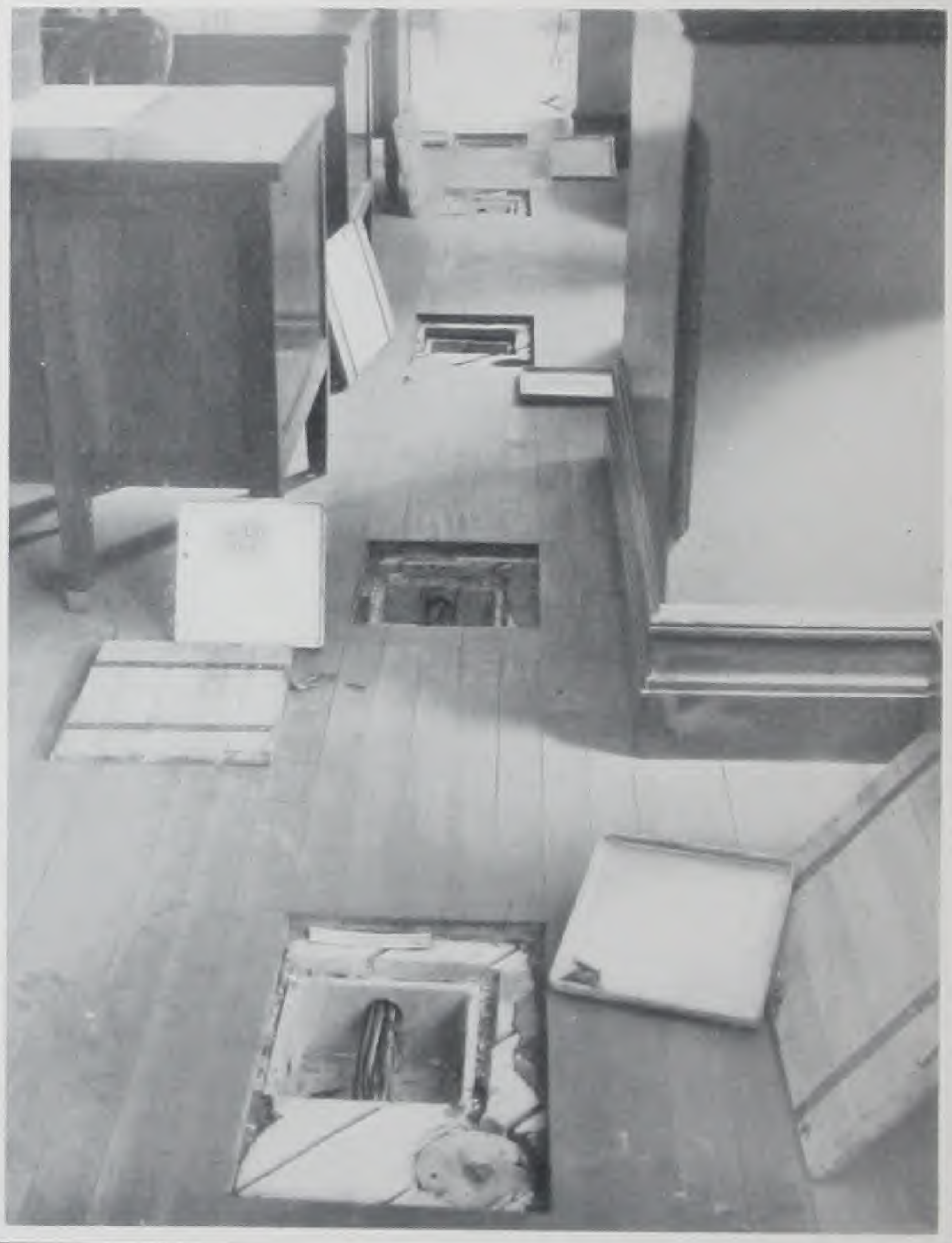


FIG. 81.—Trap Doors of Pull Boxes in Under-Floor Distribution

All home runs for lighting and low-tension circuits to panels and floor junctions are placed parallel to the trench, and they cross over opposite the panels and junctions so as to leave the floor generally free from all conduits except the desk lines.

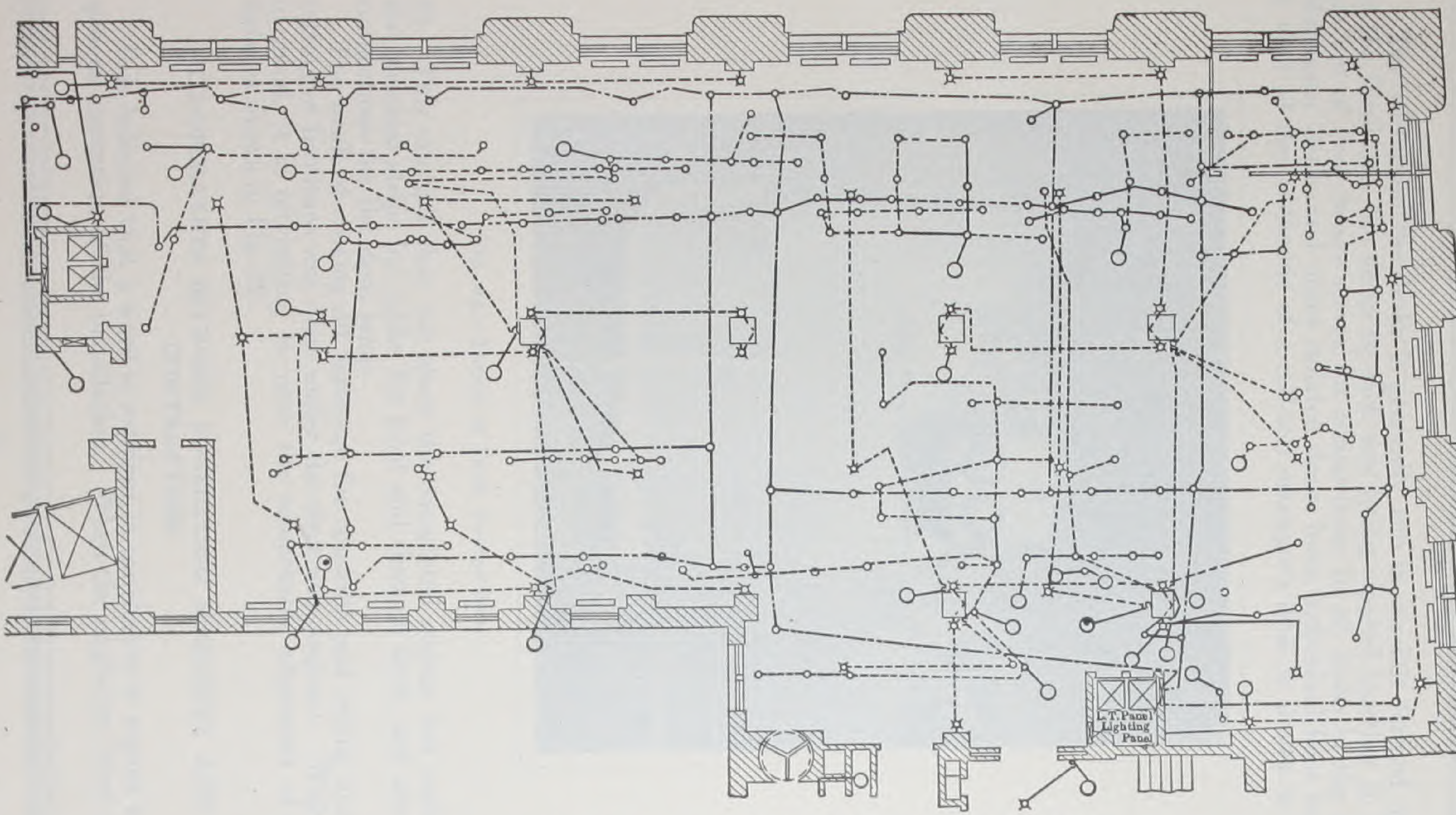


FIG. 79.—Conduit Runs Under Floor in the Old Building Before Remodeling.

The wiring on the desks is generally run in conduit formed up to fit the furniture, the desks in each row being nippled together so that one set of floor boxes serves for connections to all desks in the row. Managers' desks and other isolated desks have individual floor boxes. A view of the underside of a roll-top manager's desk is shown in Fig.

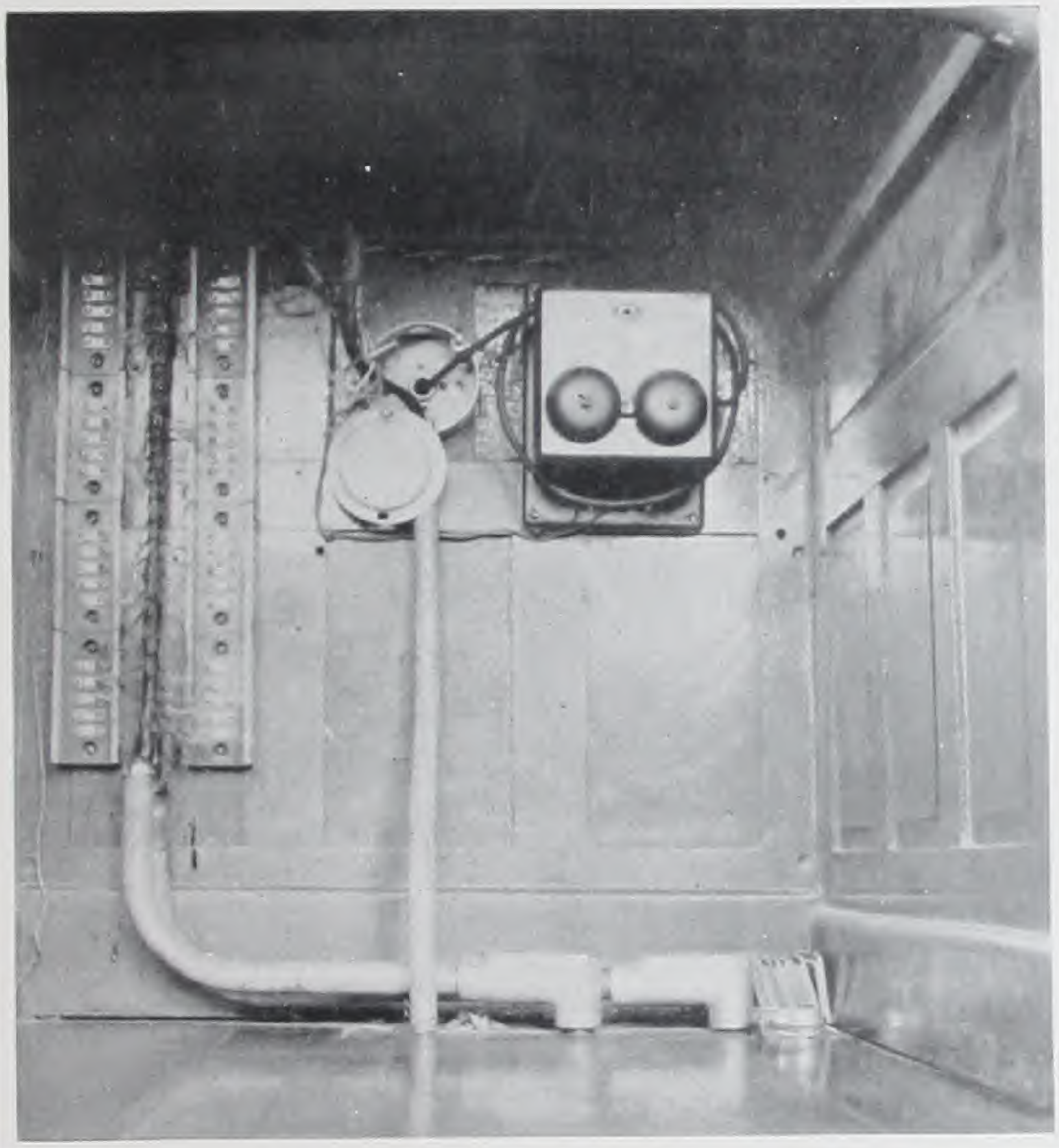


Fig. 82.—Detail of Desk Connections.

82. This example does not show the completed wiring, but indicates the terminal strips for cables for local and through lines, and also the connections for the desk lamp.

The work of cutting all furniture for conduits and wiring and the setting of furniture was done under the electrical contract. With this in mind, it is interesting to note the remarkable alignment of desk fixtures shown in Fig. 69.

CO-OPERATION BETWEEN CONSULTING ENGINEERS AND CONTRACTORS.

It is believed that a word is required in conclusion in regard to the general execution of the installation. When the engineers were called

upon to design the equipment, there was not available sufficient time in which to make as complete a study of the details of the work as is usually desirable, particularly in the old buildings and in the old plant where much of the apparatus that had to be removed could not be seen. Hence it was not possible in certain parts of the work to do more than indicate in a general way what was desired and the results to be accomplished.

The work in the North Building additions and the work of remodeling the old plant was awarded to L. K. Comstock & Company. Later the work of remodeling the old main feeder system was awarded to the same firm.

Estimates for the work included in the North Building additions and for the new plant, together with so much of the work of remodeling the old plant as could be done on a contract basis, were taken in three weeks and work was begun at once, without affording time to the contractors, L. K. Comstock & Company, to study properly the requirements or to organize their force. For two months, therefore, the consulting engineers gave much time to assisting the contractors in organizing and superintending the first steps in the installation.

The contractors at once sent to Newark a force who, in co-operation with the consulting engineers, began a detail study of the building, then partly constructed, and also a study of the details of the equipment. A complete set of working drawings based on field measurements was then prepared in which the fitting together of this complicated installation was shown to the minutest detail. The entire equipment was thus predetermined as to details in such a manner that its installation was merely a matter of labor.

The installation in the buildings of the Prudential Insurance Company is an example of the difficulties that may be overcome by intelligent co-operation on the part of the contractors with those responsible for the design of the equipment. There is no doubt that the success of the installation and its smooth operation are largely due to such co-operation not only by the electrical contractors, but also by the several manufacturers whose apparatus was employed. Furthermore, the assistance of Mr. Tysilio Thomas, of the Prudential Real Estate Department; Mr. E. G. Lender, chief engineer, and Mr. Heimbold, chief electrician, contributed no small amount to the final results of a work extending over nearly two years. Many of the arrangements used are due to the suggestions of these gentlemen, and the details of much of the equipment were suggested by them. The authors express their deepest obligations to Messrs. George B. Post & Sons, the architects, for their exceptional willingness to give all possible assistance in the solution of the problems that this installation presented.

IN ADDITION TO THE EQUIPMENT DESCRIBED IN THE FOREGOING PAGES, WE APPEND A LIST OF ELECTRICAL INSTALLATIONS RECENTLY EXECUTED BY THIS COMPANY.

OFFICE BUILDINGS

Trinity Building	New York City	Francis H. Kimball, Architect Griggs & Holbrook, Engineers
McChesney Building	Pittsburg, Pa.	Thomas H. Scott, Architect
United States Realty Building	New York City	Francis H. Kimball, Architect Griggs & Holbrook, Engineers
Seligman Building	New York City	Francis H. Kimball, Architect Griggs & Holbrook, Engineers
City Investing Building	New York City	Francis H. Kimball, Architect Griggs & Holbrook, Engineers
Hudson Terminal Buildings	New York City	Clinton & Russell, Architects
Hudson Terminal Addition	New York City	Clinton & Russell, Architects
Silversmiths' Building	New York City	Clinton & Russell, Architects
Lawyers' Title Insurance & Trust Co.	New York City	Clinton & Russell, Architects
Whitehall Building	New York City	Clinton & Russell, Architects
Prudential Insurance (Old)	Newark, N. J.	Geo. B. Post & Sons, Architects Henry C. Meyer, Jr., and Bassett Jones, Jr., Engineers
Prudential Insurance (North)	Newark, N. J.	Geo. B. Post & Sons, Architects Henry C. Meyer. Jr., and Bassett Jones, Jr., Engineers
Downtown Building	New York City	McKim, Mead & White, Architects Mailloux & Knox, Engineers
United Stated RubberBuilding	New York City	Carrère & Hastings, Architects Ewing, Bacon & Henry, Engineers
Goddard Building	Chicago, Ill.	D. H. Burnham & Co., Architects
Hearst Building	Chicago, Ill.	Jas. C. Green, Architect Mailloux & Knox, Engineers
Monroe Building	Chicago, Ill.	Holabird & Roche, Architects
McNeill Building	Chicago, Ill.	Holabird & Roche, Architects
Otis Building	Chicago, Ill.	Holabird & Roche, Architects
5th Avenue & 52nd Street	New York City	J. H. Duncan, Architect
Mallers Building	Chicago, Ill.	C. A. Eckstorm, Architect Martin C. Schwab, Engineer
Harrison Building	New York City	Goldwin Starrett & Van Vleck, Architects
Everett Building	New York City	Goldwin Starrett & Van Vleck, Architects
Consolidated Gas Building	New York City	Consolidated Gas Company
Firemen's Insurance Building	Newark, N. J.	Marvin, Davis & Turton, Architects
du Pont Building	Wilmington, Del.	Manufacturers' Contracting Co., Engineers
Central Union Gas Building	New York City	Consolidated Gas Co.
Masonic Building	New York City	H. P. Knowles, Architect Mailloux & Knox, Engineers
25th St. and Madison Ave.	New York City	C. A. Valentine, Architect Clarke, MacMullen & Riley, Engineers
McGill Street Building etc.	Montreal, Canada	R. E. Bostrom, Architect

BANKS

National City Bank Building	New York City	McKim, Mead & White, Architects Mailloux and Knox, Engineers
Farmers' Loan & Trust Co.	New York City	Clinton & Russell, Architects
East River Savings Bank	New York City	Clinton & Russell, Architects
Essex County National Bank	Newark, N. J.	Clinton & Russell, Architects
Guaranty Trust Company	New York City	Yorke & Sawyer, Architects Henry C. Meyer, Jr., and Bassett Jones, Jr., Associate Engineers
Emigrant Industrial Savings Bank	New York City	R. F. Almirall, Architect
Union National Bank	Pittsburg, Pa.	McClure & Spahr, Architects
Night & Day Bank Building	New York City	Henry Ives Cobb, Architect
National Bank of Cuba	Havana, Cuba	José F. Toraya, Architect
Queens County Trust Co.	Jamaica, L. I.	N. W. Hausman, Architect
Safe Deposit & Trust Co.	Baltimore, Md.	Simonson & Pietsch, Architects
Etc.		

PUBLIC BUILDINGS

Seventy-first Regiment Armory	New York City	Clinton & Russell, Architects
Naval Hospital	Washington, D. C.	Ernest Flagg, Architect
Naval Hospital	Annapolis, Md.	Ernest Flagg, Architect
Protestant Home for Incurables	Pittsburg, Pa.	McClure & Spahr, Architects
Kingsley Home	Pittsburg, Pa.	McClure & Spahr, Architects
Sailors' Snug Harbor	Staten Island	Mailloux & Knox, Engineers
Ives Memorial Library	New Haven, Conn.	Cass Gilbert, Architect
Blackwells Island Sub-station	Blackwells Island	Raymond F. Almirall, Architect
Elizabeth City Post-Office	Elizabeth City, N. C.	James Knox Taylor, Architect
St. Luke's Hospital	New York City	Ernest Flagg, Architect
Consolidated Stock & Petroleum Exchange	New York City	Clinton & Russell, Architects
New Temporary Post-Office	New York City	McKim, Mead & White, Architects
Chapin Home	Jamaica, L. I.	Raymond F. Almirall, Architect
Sea View Hospital—Title II	Staten Island	Raymond F. Almirall, Architect
Sea View Hospital—Title III	Staten Island	Raymond F. Almirall, Architect
Exhibition Buildings	Toronto, Canada	City Engineer
Toronto General Hospital	Toronto, Canada	Darling & Pearson, Architects Griggs & Holbrook, Engineers
Willard Parker Hospital	New York City	Wm. E. Austin, Architect
Gayety Theater	Baltimore, Md.	W. H. McElfatrick, Architect
Brooklyn Academy of Music	Brooklyn, N. Y.	Herts & Tallant, Architects Harry Bissing, Engineer

APARTMENTS AND HOTELS

Raleigh Hotel	Washington, D. C.	J. H. Hardenburgh, Architect Mailloux & Knox, Engineers
Bellevue-Stratford Hotel	Philadelphia, Pa.	Hewitt & Paiste, Architects

Belnord Apartments, Broadway and 86th Street	New York City	Hiss & Weeks, Architects
Apartment, Park Ave. & 60th Street	New York City	W. A. Boring, Architect
Duplex Apartments, 127 E. 60th Street	New York City	J. M. A. Darrach, Architect
Atelier Building	New York City	Pollard & Steinam, Architects
Central Park Studios	New York City	Pollard & Steinam, Architects
Brevoort Hotel	Chicago, Ill.	Egan & Prindeville, Architects
Prasada Apartments	New York City	Walter S. Kidde, Engineer
86th Street Studios	New York City	Pollard & Steinam, Architects
Colonial Studios, 160 W. 57th Street	New York City	Pollard & Steinam, Architects
Studios, 130 W. 57th Street	New York City	Pollard & Steinam, Architects
Studios, 136 W. 57th Street	New York City	Pollard & Steinam, Architects
Garden City Hotel	Garden City, L. I.	Ford, Butler & Oliver, Architects
Nichol Apartment and Store	Caldwell, N. J.	E. G. Matthews, Engineer
Idaho Apartments	New York City	Albert Joseph Bodker, Architect
Apartment, 1550 North Shore Parkway	Chicago, Ill.	Marshall & Fox, Architects
Apartment, 199 Lake Shore Drive	Chicago, Ill.	Marshall & Fox, Architects

DEPARTMENT STORES

Fourteenth Street Store	New York City	Cady, Berg & See, Architects
Hearn's Store	New York City	J. B. Snook's Sons, Architects
J. Spencer Turner Co.	New York City	E. L Ellis, Architect
Bamberger Store	Newark, N. J.	Jarvis Hunt, Architect Martin C. Schwab, Engineer
Rothschild Building	Chicago, Ill.	Holabird & Roche, Architects
Lytton "The Hub"	Chicago, Ill.	Marshall & Fox, Architects Martine C. Schwab, Engineer

LOFT AND MERCANTILE BUILDINGS

Baltimore-American Building	Baltimore, Md.	Simonson & Pietsch, Architects
Loft Building, Cliff and Ferry Streets	New York City	W. K. Benedict, Architect
Black Building	New York City	Buchman & Fox, Architect Walter S. Timmis, Engineer
Bush Terminal Co.	New York City	Kirby, Pettit & Green, Architects
Professional Building	Baltimore, Md.	Baldwin & Pennington, Architects
Stuyvesant Building	New York City	A. S. Gottlieb, Architect
Mackey Baking Company	Pittsburg, Pa.	N. C. Wilson, Engineer
McKnight Warehoure	Pittsburg, Pa.	A. & S. Wilson Co., General Builders
New York & New Jersey Telephone Company	Brooklyn, N. Y.	Eidlitz & McKenzie, Architects
John Farrell (Loft Building)	Pittsburg, Pa.	F. J. Osterling, Architect
L. Vilsack (Loft Building)	Pittsburg, Pa.	F. J. Osterling, Architect

Jos. W. Stern & Co. (Loft Building)	New York City	Sommerfield & Steckler, Architects
Charles Scribner's Sons (Scribner Press)	New York City	Ernest Flagg, Architect Walter S. Timmis, Engineer
Stafford Building	New York City	Lionel Moses, Architect
Jos. J. Little Printing House	New York City	Townsend, Steinle & Haskell, Architects Walter S. Timmis, Engineer
J. F. Blanchard Factory	Long Island City	Paul C. Hunter, Architect
T. J. Lipton	NewYork City	
Charlton Building	New York City	Charles C. Haight, Architect
Stockton Building	New York City	Buchman & Fox, Architects
31st Street and Fifth Avenue Building	New York City	Buchman & Fox
334 Fourth Avenue Building	New York City	Geo. B. Post & Sons, Architects Pattison Brothers, Engineers
4th Avenue and 20th Street	New York City	Rouse & Goldstone, Architects Mailloux & Knox, Engineers
507 Madison Avenue	New York City	F. A. Wright, Architect
39-41 West 32nd Street	New York City	Griffin & Wynkoop, Architects Ewing, Bacon & Henry, Engineers
Barzaghi Building	New York City	H. P. Knowles, Architect Mailloux & Knox, Engineer
Graphic Arts Building	New York City	Richard Berger, Architect Walter S. Timmis, Engineer
Etc., etc.		

FACTORIES AND POWER HOUSES

Richie, Brown & Donald	Maspeth, L. I.	A. E. Wells, Engineer
Edison Station (W. 27th St.)	New York City	N. Y. Edison Company
National Lead Works	Brooklyn, N. Y.	Henry Floy, Engineer
Milliken Brothers Steel Plant	Mariner's Harbor, S. I.	C. F. Smith, Engineer
W.W. Russell Card Company	Milltown, N. J.	
Edison Station (140th St.)	New York City	New York Edison Company
Astoria Light, Heat & Power Company	Astoria, L. I.	Consolidated Gas Co.
Consolidated Gas Company, 21st Street Station	New York City	Consolidated Gas Company
Waterside Edison Station	New York City	New York Edison Company
Williamsburg Power House	Brooklyn, N. Y.	T. E. Murray, Engineer
Pumping Stations, Gansevoort and West Streets and Oliver and South Streets	New York City	Department of Water Supply, Gas and Electricity
Terry & Tench Shops	Bayonne, N. J.	
Federal Distilling Co.	Baltimore, Md.	Chas. G. Armstrong, Engineer
Clark Thread Company	Newark, N. J.	
Chattanooga & Tennessee River Power Company	Hales Bar, Tenn.	John Bogart, Engineer
Reading Cotton Mills	Reading, Pa.	Jos. Bancroft & Sons Co. Owners & Engineers
Griswold Worsted Mills	Darby, Pa.	Griggs & Holbrook, Engineers
Hales Bar Oiling System	Hales Bar, Tenn.	John Bogart, Engineer

Hales Bar and Chattanooga Stations: Oil and Water Circulating System	Hales Bar, Tenn.	John Bogart, Engineer
Bush Terminal — Factory No. 19	Brooklyn, N. Y.	W. L. Sturgis, Engineer
Schock Building. Concrete Factory	New York City	J. Broome, Engineer
Wallace & Co., Factory	Brooklyn, N. Y.	H. A. Gilbert, Architect
Cary Mfg. Company, Factory	Brooklyn, N. Y.	Russell G. Cory, Engineer
Toronto Hospital — Power House	Toronto, Canada	Darling & Pearson, Architects Griggs & Holbrook, Engineers
Safety Car Heating & Lighting Company	Jersey City, N. J.	C. H. Caldwell, Architect Mailloux & Knox, Engineers
Sears, Roebuck & Co.	Chicago, Ill.	Martin C. Schwab, Engineer
Etc., etc.		

GARAGES

50th Street and Broadway	New York City	H. C. Hollwedel, Architect
Grand Garage	Baltimore, Md.	Simonson & Pietsch, Architects
62nd Street and Broadway	New York City	Frank M. Andrews, Architect
1780 Broadway	New York City	H. V. D. Shaw and Waid & Willauer, Architects
225 West 57th Street	New York City	H. V. D. Shaw, and Waid & Willauer, Architects
Packard Motor Car Co.	Brooklyn, N. Y.	Albert Kahn, Architect
United Electric Light & Power Company, 514-516 W. 147th Street	New York City	New York Edison Co.

SCHOOLS

Carnegie Technical Schools	Pittsburg, Pa.	Palmer & Hornbostel, Architects
Smith College Library	Northampton, Mass.	Lord & Hewlett, Architects
Public School No. 9	Brooklyn, N. Y.	C. B. Snyder, Architect
Staten Island Academy	St. George, S. I.	Clinton & Russell, Architects
SS. Peter and Paul	Pittsburg, Pa.	Ernst & Hauselmann, Architects
Toronto Univerity	Toronto, Canada	Darling & Pearson, Architects Griggs & Holbrook, Engineers
Union Free School	Irvington, N. Y.	Ewing & Chappell, Architects
Chicago Business College	Chicago, Ill.	D. H. Burnham & Co., Architects
Albany High School	Albany, N. Y.	Goldwin Starrett & Van Vleck, Architects Ashley & Kaufman, Engineers

DEPOTS

Pittsburg Railway Company	Pittsburg, Pa.	Theodore C. Link, Architect
Wabash Terminal	Pittsburg, Pa.	Theodore C. Link, Architect
Canadian Pacific Railway Station and Freight Sheds	Montreal, Canada	W. S. Painter, Architect
Kansas City Terminal	Kansas City, Mo.	Jarvis Hunt, Architect Martin C. Schwab, Engineer

RESIDENCES

Blumenthal Residence	Park Avenue and 70th St.	Trowbridge & Livingston, Architects Percival Robert Moses, Engineer
Harvard Club Alteration	27 West 44th Street	McKim, Mead & White, Architects
Ormond G. Smith	Oyster Bay, L. I.	Hoppin & Koen, Architects
Bertron Residence	14 East 78th St.	Yorke & Sawyer, Architects
Wm. H. Moffit	Islip, L. I.	Palmer & Hornbostel, Architects
J. Herbert Johnston	Cold Spring, L. I.	Willauer, Shape & Bready, Architects
Wm. Fahnestock	Katonah, N. Y.	Charles A. Platt, Architect
Francis S. Lloyd	Bernardsville, N. J.	Geo. B. Post & Sons, Architects
Geo. B. Post	Bernardsville, N. J.	Geo. B. Post & Sons, Architects
W. G. McAdoo	13 West 48th Street	Clinton & Russell, Architects
T. M. Turner	New Rochelle, N. Y.	Edmond Lewis Ellis, Architect
H. S. Black	Purchase, N. Y.	
F. A. Vanderlip	Scarborough, N. Y.	
W. J. Harroch	Pittsburg, Pa.	
Mrs. H. P. Dyer	Rye, N. Y.	Albert Joseph Bodker, Architect
John F. Dryden	Newark, N. J.	W. L. Stoddart, Architect
J. Rich Steers	37 East 67th Street	
Kenyon Residence	Poughkeepsie, N. Y.	Percival H. Lloyd, Architect
R. B. Ward	New Rochelle, N. Y.	Charles Barton Keen, Architect
Jos. S. Frelinghuysen	45 East 68th Street	C. P. H. Gilbert, Architect
Townsend Jones	140 West 74th Street	Edmund Lewis Ellis, Architect
Residence	45 W. 57th St., N. Y. C.	
Howard Murray	Montreal, Canada	Ross & MacFarlane, Architects

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